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SALES hereby certify that annexed is a true copy of the Provisional specification
in connection with Application No. 2002952792 for a patent by MALCOLM
LEONARD STEPHEN DEAN as filed on 15 November 2002.

WITNESS my hand this
Third day of December 2003

JULIE BILLINGSLEY
TEAM LEADER EXAMINATION
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**PROVISIONAL SPECIFICATION
FOR A PATENT.**

in the name of

MALCOLM DEAN

entitled

“VARIABLE RATIO MULTI-GEAR”

(Page 1B will follow similarly to what was the arrangement in the previously applied for Provisional Patent)

TITLE VARIABLE RATIO MULTI-GEAR

The same page numbers are used as the previous applications where possible.

Some of the previously accepted and published patent applications are included or referred to.

The Converter Full Patent similar to the sealed Petty is included with the correction to the third claim as mentioned, replacing the word "the" with "or" on line 20.

There is also included the option that the mechanical variable ratio design described in P.C.T/AU02/ 00305 (or for any of these patent application designs) as operating not necessarily with slip, i.e. may operate, and be further advanced using a Variator or similar.

Page 1B, A Power Converter description is included as before.

There is the hydraulic enhancement for optional bike use.

There is also the amended uncorrected 93246/98 Patent and Claims. Some which were in some cases said to go beyond the original disclosure by the examiners and therefore advice was given that a new application should be applied for these itemised parts.

A combination of these several fundamental areas of technology may be integrated, together with further advancement.

A summary of some of the past and also the present advancement follows.

The drawings numbers could refer to any of the applications.

SUMMARY OF TRANSMISSION

As well as being able to be placed anywhere between the power source or sources and the load or loads, the fundamental enormous Historic advance is to provide infinitely variable speed drives on one axis for everything that moves, such as windmills mobiles and all vehicles. One of the breakthroughs that this transmission represents is that it is also stepping up as from 1973 prior art described on page 1 of AU 93246/98 herewith referring to patent A 465202/73 by "Eaton Corporation" describing a powerful, self-contained freewheeling two speed motor wheel only requiring one power source. However their transmission only becomes practical due to the quick reversibility provided by a hydraulic motor.

In order to similarly provide fixed ratios from one end, multiple concentric inputs/output carriers/cages can be provided allowing any single power source to provide sequential steps in ratios by clutching these together with the body sequentially with one way restrictions, with reference to frame, or ground. This is without having to reverse the power source direction as has been necessary previously with the Eaton drive.

However, the present invention can further include the ability to bring the load right up to a 1 to 1 ratio with any chosen single power source, at which time there are minimal or no wearing parts as there can be a direct coupling between power source and wheel/load.

Added features such as providing a reverse gear from one same end, optionally motor braking or freewheeling is also available. Everything can even be within the wheel if required, or this transmission may be supporting the wheel and combining the single power source. The power source could support everything, or this transmission can be inside the power source.

With a single power source by providing more gear transitions by restricting reversing of contra-rotating components until inbuilt sequential design allows overtaking of the one way restriction, as the input rotational speed exceeds the one way components restrictions until each next transition is reached. There are also various types of one way control and any type of sprag clutches may be used, some others are described in Arthur Woodbridge's patents numbered on page 1 of my first patent following.

An example can be better understood by referring to the patent drawings 4, (left side of page, being fig. 4A (*Fig 1*) and similarly as in fig 6, (*Fig 2*) by referring to the left side of the drawing shown able to be split in the centre at the flange shown (*left side 10, or 5 abc*) (*right side, 5/2, to be numbered 30*) and able to optionally drive the load with the body, (as in 4A, which indeed could also be part of the wheel or within the wheel or support the wheel). This is similarly shown in fig 4A)(*Fig 1*) which shows a first rotor driving the "no. 1 inner cam 3a" (*17*), with the body shown here having a keyway output shaft. Fig 6 also shows input (*13*) that similarly drives "No. 1 inner cam 3a" and also here however it drives another cam *3/2 (37)*. These items are shown here numbered in italics in the new amended drawings with the "input" 1 as the centre shaft numbered *13*, with a second input cam (*37 to be numbered*) with a second keyway to the shaft shown, providing more alternative output ratios.

In a simple operating example a first centrifugal or manual clutch (not shown) could allow an I.C. motor (not shown), to idle. Refer to Fig 4A, (*1*), If the rotational force is applied to Item 1 (*13*) and cam 3a (*17*) with a reverse rotational restriction placed on the D6 (*22*) component, referenced to ground, then a geared torque will be applied to the body 5a and b (*21*).

providing the first geared transition. A corresponding reverse rotation will also commence in the other input/output cam 3b/rotor (*cam 16*). In one simple method, a centrifugal frictional clutch between the centre shaft item 1 (*13*) and this second cam 3b (*16*) could very simply bring the body up to a 1 to 1 ratio with the input source, by restricting the reverse rotation of (*16*) and thus driving cam (*16*) forward. This also causes the D6 (*22*) component to start a forward rotation leaving the one-way restriction, thereby further propelling the body (*21*) forward. Energy storage can also be propelled by this cam 3b (*cam 16*), also combined self-starters and regenerators for I.C. Motors, flywheels or similar, or a second input rotor (*15*) as shown_(HYBRID DRIVES ARE VERY COMPATABLE WITH THIS INVENTION)

In another method, the spaces between the rollers and scallops (*20 and 21*) driven by the inner cam (*17*) can provide a pumping action during the first transition, with even just the lubricant which could be channelled between the rollers and scallops (*19,21*) of the 3b (*cam 16*) and body. By discreet design, the pumping pressure could "motor" this cam (*16*). With the increase of rotational speed of the body and centrifugally channelling the oil to provide the motoring of the cam (*16*), this could also be designed to provide automatic governing, such as by allowing the rotation speed of the cam to slip in proportion relative to the rotation speed of the load. More complex centrifugal governing of many types can be used, such as using special flow valves and control valves. Internal or external energy storage can be combined, such as described throughout this patent. By incorporating more concentric accesses to cages more sequential steps can be allowed for as for example each one way clutching point being automatically (or manually selected) is exceeded by the input speed.

A reverse gear can further be provided from the one end and can be actuated by restricting the rotation of this added input which can be concentrically accessed beside the others, and having the suitable forward rotating ratio chosen between carrier and body, similarly to the reverse rotating ratio of the cam (16).

Multiple cage/carriers can be used so that multiple gears can be obtained from multiple transitions, concentrically accessed.

Alternatively the load or wheel can be taken from item 2 or 4 on Fig 6 (28 or 29 of Fig 2) (further the load can be through any couplings and/or to other axis).

Though there are many options shown, there is also provided a historic breakthrough in driving a load directly without necessarily the need for even a housing/box. This allows for extremely high speed/frequency motors with for example, only the relative speed difference between the input and output to cater for when relating to the support required.

The great advance is that the intrinsic nature of this fixed ratio gear design allows the multiple gearing inputs and outputs to become dynamically interrelated, the components of all the relative reference points can be exploited as they are all moving relative to each other.

The gear shafts can be massive where required for extremely low ratio leverage enabling the whole structure of the machines to be "alive".

Some hybrid description of this invention given on page 34/2 from line 11 to 29 was given by a highly respected Engineering Professor He suggested it as an advancement for Toyota and is very appropriate, particularly with reference to their hybrid drives.

Many energy storage and integration of rotational force options are possible. Governor action can further be controlled by the intrinsic dynamic nature of the transmission having fixed ratios, which may

centrifugally equalise the inputs and outputs for optimum operation. (Electronic control for optimum performance together with maximum efficiency is extremely complementary to this transmission and relatively low cost, with manual over-riding being available).

Further describing it also as a "Pulley" system he further explained how some of the more exciting features of the dynamic component of this invention can be better understood, by viewing Fig 6 as showing an "internal view" Fig 12 as showing an "external view" (the three dimensional view being seen for example by looking at Fig 30, showing the car and passengers tiling into the corner like a motor-cycle instead of throwing out.)

Other advanced body shapes and structures may be used such as for strength, low wind resistance ease of manufacture. By using the extremely indestructible structural shape which may be understood as a THREE IN ONE structure which provides the minimum surface area to maximum capacity and may be understood to have physical, scientific, chemical and spiritual dimensions and connotations. Three equilateral triangles form the basis of this structure with the ability to view right around a 360-degree path in any direction in our three dimensional world, called a tetrahedron. However in order to provide substance and capacity, we have to have a fourth side, (which can be positioned anywhere from infinity to infinity) this fourth side is also an equilateral triangle. Einstein postulated that our world is three-dimensional, where a fourth dimension can be understood as being time.

A scientist together with a group of researchers are claiming enhanced water as available from the Hunza Valley as able to provide the elixir of life. The structure of the water molecule is changed and cannot be demonstrated or shown as normally on a flat surface, but described as

having an extra electron and needing a tetrahedron to show the molecular structure. (As yet to be successfully provided and transported to reach the consumer economically.)

This tetrahedron structure further can be extended into as many more of these triangles if required thereby providing extremely strong enclosures.

Rectangular connecting panels for extending enclosures for example for building longer high-speed vehicles would be one option.

The bodies of this transmission may be manufactured by any known method, being described as "laminated", the scallops or ring-gear may be provided side by side in any known method where there is no rotational movement in between them.

As described previously they can be inside the wheel, the scallops can be machined inside the wheel hub, inside complete with motor, (or contra-rotating motor). Or other epi-cyclic designs could be used where the bodies may be, for example within each other. Or pump combinations may be used without differentiating from the present invention.

(There is the exception shown in for example in Fig 11 where there is a flange showing very clearly where such a split would be such as for fans or similar. However the latest Patent P.C.T. 00305 does have a split body, but between the first epicyclic movement double carrier as an alternative design). Any number of ring gear/scallops could be manufactured in one piece, simply bolted together or slid into rotational restricting cavities, or enclosed (see inserts to add or change ratios in item 32 page 42 or page 71, line 21), or any other epicyclic design may be used such as described in page 1 of this patent.

Some wording used in this patent such as "heterodyning" can be better understood by referring to the description as understood by a "Technical

electronics instructor" on page 45, line 22, also see a motor designers description on page 22 line 16. Mechanical Engineering people may understand "heterodyning" better perhaps as a type of multiple resonances.

Another simple way of understanding the simplicity of this invention is as a type of Yo-Yo action performed on one axis, able to combine with many others

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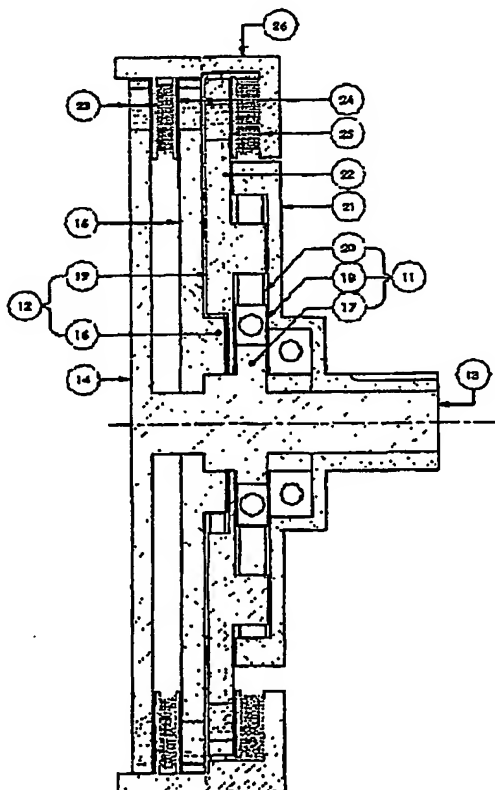
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(54) Title: VARIABLE RATIO TRANSMISSION



(57) Abstract: A variable ratio transmission having an input (14) and an output (21) and being of the epicyclic type involving a sun element (17, 19), a ring element (21) and a planet carrier element (22) in each of at least first (11) and second (12) unequal co-axial epicyclic assemblies, a second rotating element (22) of the first assembly (11) and a second rotating element (22) of the second assembly (12) being constrained to rotate at a common angular velocity, and control means (25) for progressively changing the gear ratio applied to a load connected to the first rotating element (21) of the first assembly (11), characterised in that the first rotating elements (21) are unequal pairs of the same mechanical elements of the respective assemblies (11, 12) and in conjunction with respective second rotating elements (22) each represents different respective fixed gear ratios relative to the input (14) and the output (21) of the transmission, the second rotating elements (22) are unequal pairs of the same mechanical elements of the respective assemblies (11, 12) and in conjunction respective said first rotating elements (21), each represents fixed gear ratios between the input (14) and output (21), the control means (23, 25) operable to progressively increase or decrease the output gear ratio as operation demands.

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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 1040 1

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

VARIABLE RATIO MULTI-GEAR

TECHNICAL FIELD OF THE INVENTION

This invention relates to a variable speed transmission of the epicyclic type.

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BACKGROUND TO THE INVENTION

Epicyclic gear trains, also referred to as planetary gear trains, are those in which one or more gear elements orbit about the central axis of the train. Thus, they differ from an ordinary train by having a moving axis or axes. The trains involve the interaction of three mechanically distinct rotating elements, namely a sun-element, a ring-element and a planet-carrier-element. The planet-carrier-element being a link that mounts one or more planet elements.

Epicyclic gear trains are, fundamentally, two-degree-of-freedom systems. Therefore, two inputs are required before they can be uniquely analysed. Quite frequently a fixed gear is included in the train. Its angular velocity is zero, but this zero value constitutes one of the input values. Any sun-element, ring-element or planet carrier-element can serve as an input or output.

The equation for Power is:

$$P = T * \omega$$

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Where P = Power

T = Torque

ω = angular velocity

The power through any of the rotating elements of the epicyclic gear train therefore is proportional to the torque and angular velocity of the element. Power is conserved through any system meaning that the power into a system equals the power out of that system. Some of the energy transferred through the system may be dissipated or stored as non-useful energy and therefore the useful power output from a system may be different to the power into the system.

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If an epicyclic train with one of the degrees-of-freedom constrained from rotating has the resistive torque acting on its output reduced, and the input power remains the same, the speed of the output will increase. The power in equals the power out and assuming that the dissipative power is small relative to the input power, the useful power out will be similar to the power in. The fixed ratio of output to input means that a change of torque at the output means a changed torque requirement at the input. If the input power is constant then if one of either the input torque or angular velocity changes then the other will adjust also. So the input angular velocity increases so that the product of the input torque and angular velocity remains the same. If further the input angular velocity remains constant, then as the resistive torque acting on the output is reduced further, the element constrained from rotation can be released and the power not used at the input can be diverted to that element in such a way that it uses the power to increase its speed and therefore increase the output speed.

An object of the present invention is to use the balancing of power discussed above to provide a variable speed transmission of the epicyclic type as a useful alternative to the prior art.

OUTLINE OF THE INVENTION

This invention relates to devices for the transmission of mechanical power, in the form of rotational motion. In particular, it is directed to the transmission of power between one or more motive sources and one or more resistive torques (loads) to provide a device which can provide, in a preferred form, continuously variable ratios between the angular velocity at an output to the angular velocity of an input. The continuously variable ratios can be selected manually, or in a preferred form automatically by self-regulating means, and can provide variable output angular velocity and variable torque multiplication.

The present invention finds uses in many applications including electronic, hydraulic and mechanical. Examples of similar drives are Australian patents 607822

and 613927 as spin control differentials for vehicles and couplings. Australian patent 607822 protects the use of a double cam, which enables ratios that would not be practical with the use of a single cam where cycloidal elements are used and the double cam enables balancing. Australian patent 607822 describes the use of certain types of sprag-clutches. The Australian patent 607822 has been assigned to M.L.S. Dean. Eaton Corporation has an Australian Patent number 465202 based on a planetary drive that has a sun gear, a ring gear and a planet carrier. Sumitomo Heavy Industries Ltd, Japan, under the name "Cyclodrive" manufacture examples of planetary drives.

Although planetary gears are known, the known prior art gears have failed to take advantage of certain of their features, in particular, the contra-rotational nature of the input and output shafts being on the same axis. This invention optionally provides in a one-body transmission a more practical way of supporting the load from one side than known prior art. It also can provide a continuously variable ratio from one input and can have this variable ratio controlled by a control means that does not necessarily rely on slippage and has the capabilities of being self-regulating.

The invention is capable of absorbing energy from the load connected too an output or supplying energy to an output, thus providing regenerative braking or acceleration according to an output power demand.

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In one aspect the invention provides a variable speed transmission having at least one input and at least one output and being of the epicyclic type using toothed gearing or preferably cycloidal arrangements involving interaction of three mechanically distinct rotating elements, namely a sun element, a ring element and a planet carrier element in each of at least first and second unequal co-axial epicyclic assemblies, a first rotating element of the first assembly free to rotate and a first rotating element of the second assembly constrained to rotate at a controlled angular velocity relative to a fixed frame of reference , a second rotating element of the first assembly and a second rotating element of the second assembly being constrained

to rotate at a common angular velocity, and control means for progressively changing the gear ratio applied to a load connected the first rotating element of the first assembly of the Variable Ratio Multi-gear characterised in that the first rotating elements are unequal pairs of the same mechanical elements of the respective assemblies and in conjunction with respective second rotating elements each represent different respective fixed gear ratios relative to the input and the output of the Variable Ratio Multi-gear, the second rotating elements are unequal pairs of the same mechanical elements of the respective assemblies and in conjunction with respective said first rotating elements each represent fixed gear ratios between the input and the output of the Variable Ratio Multi-gear, a third element of the second assembly rotating at a controlled angular velocity, the control means being operative to progressively increase or decrease the output gear ratio automatically in accordance with the demand.

In the description "output higher gear stage of operation" means "higher" in the sense of a gear ratio approaching 1:1 ratio as input to output, while "output low gear stage of operation" means an output gearing in the opposite sense generally corresponding to a lower output angular velocity.

The first rotating elements are typically the ring elements of the respective assemblies. The ring elements are preferably outer bodies having spaced endless scallop guides, each scallop guide having a relatively unequal number of scallops to rollers in either side depending on the required gear ratios for a particular application and the guides being adapted to receive sets of planet rollers of the planet carrier elements.

The second rotating elements are typically the planet carrier elements of the respective assemblies. The planet carrier elements are typically formed as an integral unit housing spaced sets of rollers with relatively unequal numbers relative to the number of scallops, with the rollers corresponding to the planets of each assembly, the rollers bridging between the scallop guides of the outer bodies and the third elements of the assemblies. The planet carrier is preferably constrained by a rotation

blocking means to travel in one direction only. The rotation blocking means is preferably a selective rotation blocking means enabling selection of rotation of the second rotating elements in forward or reverse direction. The rotation blocking means may in some applications be allowed to rotate at a controlled angular velocity in the

5 direction that it is blocking to enable a further reduced output low gear stage of operation.

The third elements of the assemblies are typically sun elements in the form of respective cams, with at least one cam and in practical terms both cams typically having a roller bearing or bush assembly separating the cam into an inner cam and a

10 cam ring able to travel opposite the direction of the inner cam.

The control means can be any means that enables a variable rotation to be supplied to the third element of the second assembly across a continuous range of output gear ratios between zero and a speed that causes the planet carrier element angular velocity to equal the angular velocity of the third element of the first

15 assembly.

Modules made up of the first and second assemblies can be employed in various arrangements with various inputs and outputs and connections between modules for various applications. What is common is that each of the first and second assemblies of each module share a common planet element, the first element of the first

20 assembly is connected to the load directly or to another module and the first element of the second assembly has its angular velocity controlled relative to a fixed frame of reference which the angular velocity for some applications will be zero relative to a fixed frame of reference, the third element of the second assembly has its angular velocity controlled relative to the third element of the first assembly and may vary or

25 not vary proportionally to the angular velocity of the third element of the first assembly. The control of the angular velocity of the first element of the second assembly relative to a fixed frame of reference can be done by a plethora of means including hydraulics with the displaced hydraulic fluid being directed so as to use the power in the fluid to add to the input power.

In practice for some applications there may need to be a braking system that connects the first element of the first assembly to the third element of the first assembly or directly to the input to stop an overrun situation where the input angular velocity to the third element of the first assembly has been reduced and the inertia of elements connected to the first element of the first assembly needs to be controlled.

BRIEF DESCRIPTION OF THE DRAWING

Figure 1 has been given as an illustrative example of the present invention and many variations and modifications thereto will be apparent to those skilled in the art without departing from the broad ambit and scope of the invention as herein set out in the appended claims. Figure 1 is a variation indicated in the diagram previously labelled Figure 4A. The variations of Figure 4A were indicated by the element numbering system. The following table shows the correlation between the element numbers in Figure 1 and those in the diagram previously labelled Figure 4A.

Figure 4A Element	Figure 1 Element	Description
1	13	Input shaft
3a	17	Cam – Sun Element
3b	16	Cam – Sun Element
5b	21	Body (Output) – Ring Element (scallops are indicated as 9 in Figure 4A)
5c	26	Body – Ring Element (scallops are indicated as 9 in Figure 4A)
14	14	Rotor
15	15	Rotor
D6	22	Cage - Combined Carrier Element for assemblies 11 and 12.

METHOD OF PERFORMANCE

In the example illustrated in Figure 1, the module employs first and second unequal co-axial epicyclic assemblies (11) and (12), these are both of the cycloidal type, that is, employing scallops and rollers.

Modules employed will vary in specific arrangement for other applications. What is common is that each of the assemblies (11) and (12) share a common planet element. The sun elements are separate cams, rollers bridge between the cams and the scallops. The planet element comprises a planet carrier bridging axially between the assemblies having opposite sides which are relatively unequal in terms of the number of rollers to the number of scallops carried by the planet carrier, while the ring element comprises an outer body having scallops arranged so the assemblies each represent different fixed ratios relative to an input and an output.

This means the planet carriers of the two assemblies are constrained to rotate at the same angular velocity. In the illustrated embodiment the angular velocity of the output (21) could be zero.

In each assembly the cams are eccentric cams which rotate in co-operation with the scallops and roller configuration of the respective assemblies. One of the cams is driven by an input shaft, this will cause the output, that is the outer body, to rotate while the other cam rotates according to a variable ratio which may be connected to the same input as the other cam. The output gear ratio is influenced by the angular velocity of the second cam, thus various arrangements for applying a variable ratio to the second cam will influence the output in a controllable fashion according to demand.

While the above description deals with the general features involved, the following description will enable understanding of the application of the invention to the specific application of Figure 1.

Figure 1 shows a Variable Ratio Multi-gear multi-gear according to the invention an Input, which is a rotor (14) an output (21) and electrical coil and

permanent magnet arrangements (23 – 25) that apply torques respectively to rotors (14, 15) and a planet element in the form of a cage (22).

Items (23), (24) and (25) are arrangements of permanent magnets and electrical coils so that with electricity flowing through the coils, interacting magnetic fields are produced which cause a torque on the rotors (14), (15) and cage (22) respectively. The electricity supply can be adjusted individually for each of items (23) to (25). The electrical coil and permanent magnet arrangements (23 – 25) could be replaced by any type of motive sources and could be connected to the cams (16) and (17) in a plethora of ways.

The body (26) can be split at the dashed vertical dashed line (shown at the top and bottom of body (26)) and the left part of body (26) held relative to a fixed frame of reference and the right part being constrained to rotate about the same axis as cams (16) and (17) at a controlled angular velocity relative to the left part of body (26). The body (26) would be most likely split as described above in an arrangement where the input to cam (16) was constant or fixed at a constant ratio to the angular velocity of cam (17). In the following example the body (26) is not split and the whole of body (26) is held relative to a fixed frame of reference.

The rotor (14) and input shaft (13) are combined as an integrated part in this module. As an alternative, the rotor (14) could be removed and the input could be solely from an external motive source driving the input shaft (13). The point is the module comprising the groupings (11) and (12) remains the same.

Assembly (11) is the first unequal coaxial assembly and comprises of a cam {sun-element} (17), bearing (18) and rollers {planet-element} (20). The cam (17) is fixed to the input shaft (13), which is therefore fixed to the input. The bearing (18) has an inner sleeve fitted to the outer diameter of the cam (17). The bearing has an outer sleeve, the outer sleeve of the bearing (18) makes contact with the rollers (20). As the input rotates, the cam (17) causes the bearing (18) to move in an eccentric fashion. This causes the rollers (20) to be cyclically displaced away and towards the central axis of the Variable Ratio Multi-gear, the total displacement relative to this

central axis, being twice the cam axis offset from this axis. The rollers (20) are located in equally spaced guides in the cage {planet element} (22). The rollers (20) make contact with scallops in the output {ring element}(21). For both assemblies (11 & 12), the number of scallops relative to the number rollers in contact with the scallops, determines the direction of rotation it would rotate the cage (22) if the body the rollers act against, bodies (21) and (26), were held still. One more scallop than the number of rollers gives a cage rotation direction the opposite to the cam rotation. One less scallop than the number of rollers would give a cage rotation the same as the cam rotation. The scallops are so shaped that as the rollers are acted on by the cam, the scallops rotate relative to the cage at a constant angular velocity ratio to that of the cam. The action between the cam (17), bearing (18) and rollers (20) against the output (21), causes an equal and opposite reaction on the cage (22), tending to rotate it in the opposite direction to the rotation of the output (21). The cage (22) is constrained by a rotation blocking means (not shown) in such a way as to allow the cage (22) to only rotate in a direction the same as the output (21) and optionally at a controlled angular velocity in the direction that it is blocking. Therefore because of the reactive forces, the cage (22) will be held against the rotation blocking means with just the actions of assembly (11) alone. The magnetic effects caused by items (25) can drive the cage (22) (with the same action as (23) does on item (14)). The torque caused by items (25) would need to be higher relative to the torque required at the cams (16) and (17) and so is an ancillary action and not necessary for the central concept of the present invention although it may be necessary for some applications to include it. The rollers will rotate about there own axis as they move in relation to the scallops. The bearing (18), is added to eliminate the sliding action of roller (20) against cam (17), which would occur (if they were in direct contact) because of the difference in the direction of there angular rotations. The output (21) is constrained to rotate about the central axis of the input shaft (13). The cyclical movement of the rollers (20) acting on the scallops alone, causes the output (21) to rotate at a reduced rotational speed depending on the number of rollers and scallops.

For example, if the cage (22) is constrained from being able to rotate, and if assembly 11 has four rollers (20), and there are five scallops in the output (21), the ratio would be one output (21) revolution for every five revolutions of the cam (17) with the output (21) rotating in the same direction as the cam (17). If the output (21) was held and the cage (22) free to rotate, the ratio would be one cage (22) rotation for every four of the cam (16) in the opposite direction of rotation to cam (16). The rotation blocking means discussed above would normally block this rotation although the direction that is blocked will have to be changed to allow reversing or other functions.

Assembly (12) is the second unequal coaxial assembly and comprises of a cam (16), and rollers (19). The scallops in the output (21) make contact with the rollers (19) which make contact with the cam (16). The cam (16) is fixed to the rotor (15). The rotor (15) drives cam (16) through the action of the magnet and coil arrangement (24). A bearing could be optionally fitted to the outside diameter of the cam (16). The relative number of scallops and rollers for assembly (12) are different to the numbers for assembly (11). The rollers are located in equally spaced guides in the cage (22). The cage therefore bridges axially between assemblies (11) and (12) and the rollers (19) are constrained to rotate at the same angular velocity about the central axis of the input shaft (13) as the rollers (20) of assembly (11). The numbers of scallops and rollers are such that if the body (26) is constrained from being able to rotate, the action of the cam (16) against the rollers (19) and the consequential rollers (19) against the scallops in body (26) will cause the cage (22) to rotate in the same direction as the cams (16) and (17). The action of cam (17) therefore tries to rotate the cage (22) against the rotation blocking means and cam (16) tries to rotate the cage (22) away from the rotation blocking means.

For example, if the body (26) is constrained from being able to rotate, and the cage (22) free to rotate and if assembly (12) has four rollers (20), and there are three scallops in the body (26) the ratio would be one cage (22) revolution for every four revolutions of the cam (16), with the cage (22) rotating in the same direction as the

cams (16) and (17). This is the same ratio that cam (17) would rotate the cage (22) if the output (21) is constrained from rotating, but in the opposite direction to the action of cam (16). Therefore with the same torque input to both cams (16) & (17) then the torque by cam (17) tending to hold the cage (22) against the rotation blocking means
5 will be balanced by the torque by cam (16) tending to lift the cage (22) away from the rotation blocking means.

If the assembly (11) cam (17) is caused to rotate, the output (21) will rotate at another angular velocity, being a fixed ratio to the input angular velocity. The assembly (12) cam (16) will rotate at an angular velocity dependent on the input from
10 the magnet and coil arrangement (24), and for the central concept of this arrangement, in the same direction to cam (17). The cam (16) will have no effect on the output angular velocity until the electrical coils of items (24) are activated. With the electrical coils activated, a torque is transmitted through the rotor (15) to the cam (16). The electrical coils could be activated so that the torque acts in the same or
15 opposite direction as the rotation of the cam (17). The torque in this arrangement would act in the same direction as the rotation of the cam (17), the output (21) would rotate at the angular velocity determined by the fixed ratio but with an increased rotation dependent on the amount of rotation contributed by the action of items (24) on cam (16) (via the rotor (15)) onto the cage (22). It is the rotation of the cage (22)
20 that causes the output to increase its angular velocity relative to the input angular velocity. When the angular velocity of the cage (22) reaches the same angular velocity of cam (17) there is no relative difference in angular velocities between the two, therefore the output (21) will rotate at the same angular velocity as the input (13). Any angular velocity of the cage (22) between zero and the angular velocity of
25 the input will give an angular velocity of the output (21) between a ratio determined by the fixed ratio of assembly (11) and the angular velocity of the input. If the arrangement shown in Figure 1 is operating with the maximum possible power supply to the electrical coils and the input (13) is rotating at a constant angular velocity, then there would need to be a relative reduction in the output (21) resistive torque

(hereafter called the 'load') before the coils of items (24) would be supplied power. With a reduction in load, the torque required by cam (17) reduces because of the fixed ratio of assembly (11). The power required by the coils of items (25) therefore is reduced. When the reduction in load is of a sufficient value that the power not used
5 by the coils of items (25) can be used by the coils of items (24) to provide enough torque to cam (16) to rotate the cage (22) away from the rotation blocking means, then power is supplied to the coils of items (24). The output gear ratio therefore can be progressively decreased from the fixed ratio of the first assembly to a 1:1 ratio by progressively increasing the torque acting on the cam (16) from zero to a value that
10 causes the cage (22) to rotate at the same speed as the input (13). The output torque is inversely proportional to the output angular velocity.

Whilst the above has been given by way of illustrative example of the present invention many variations and modifications thereto will be apparent to those skilled
15 in the art without departing from the broad ambit and scope of the invention as herein set out in the appended claims.

CLAIMS:

1. A Variable Ratio Multi-gear having an input and an output and being of the epicyclic type involving interaction of three mechanically distinct rotating elements, namely a sun element, a ring element and a planet carrier element in each of at least first and second unequal co-axial epicyclic assemblies, a second rotating element of the first assembly and a second rotating element of the second assembly being constrained to rotate at a common angular velocity, and control means for progressively changing the gear ratio applied to a load connected to the first rotating element of the first assembly of the Variable Ratio Multi-gear characterised in that the first rotating elements are unequal pairs of the same mechanical elements of the respective assemblies and in conjunction with respective second rotating elements each represent different respective fixed gear ratios relative to the input and the

output of the Variable Ratio Multi-gear, the second rotating elements are unequal pairs of the same mechanical elements of the respective assemblies and in conjunction with respective said first rotating elements each represent fixed gear ratios between the input and the output of the Variable Ratio Multi-gear, the control means being operative to progressively increase or decrease the output gear ratio in accordance with the demand for an output lower or higher gear stage of operation.

5 2. The Variable Ratio Multi-gear according to claim 1 wherein the first rotating elements are the ring elements of the respective assemblies, the ring elements being outer bodies having spaced endless scallop guides, each scallop guide having
10 unequal numbers of scallops and the guides being adapted to receive sets of planet rollers of the planet carrier elements, the second rotating elements being planet carrier elements of the respective assemblies, the planet carrier elements housing spaced sets of rollers of unequal numbers of rollers corresponding to the planets of each assembly, the rollers bridging between the scallop guides of the outer bodies
15 and the third elements of the assemblies, the planet carrier elements being constrained by a rotation blocking means allowing rotation in one direction and a controlled rotation in the other direction, the third elements of the assemblies being sun elements in the form of respective cams.

20 3. The Variable Ratio Multi-gear according to claim 1 wherein the first rotating elements are the ring elements of the respective assemblies, the ring elements being outer bodies having spaced endless scallop guides, each scallop guide having
25 unequal numbers of scallops and the guides being adapted to receive sets of planet rollers of the planet carrier elements, the second rotating elements being planet carrier elements of the respective assemblies, the planet carrier elements housing spaced sets of rollers of unequal numbers of rollers corresponding to the planets of each assembly, the rollers bridging between the scallop guides of the outer bodies and the third elements of the assemblies, the planet carrier elements being constrained by a rotation blocking means allowing rotation in one direction and a controlled rotation in the other direction, the third elements of the assemblies being

sun elements in the form of respective cams, the control means being operable to supply a variable rotation to the third element of the second assembly across a continuous range of output gear ratios between low and high angular velocities at respective predetermined low and high output angular velocities.

5 4. The Variable Ratio Multi-gear according to claim 1 wherein the first rotating elements are the ring elements of the respective assemblies, the ring elements being outer bodies having spaced endless scallop guides, each scallop guide having unequal numbers of scallops and the guides being adapted to receive sets of planet rollers of the planet carrier elements, the first rotating element of the second
10 assembly constrained to a fixed frame of reference, the second rotating elements being planet carrier elements of the respective assemblies, the planet carrier elements housing spaced sets of rollers of unequal numbers of rollers corresponding to the planets of each assembly, the rollers bridging between the scallop guides of the outer bodies and the third elements of the assemblies, the planet carrier elements
15 being constrained by a rotation blocking means allowing rotation in one direction and a controlled rotation in the other direction, the third elements of the assemblies being sun elements in the form of respective cams, a third element of the second assembly rotating at a controlled angular velocity the control means being operative to progressively increase or decrease the output gear ratio in accordance with the
20 demand for an output lower or higher gear stage of operation.

5. The Variable Ratio Multi-gear according to claim 1 wherein the first rotating elements are the ring elements of the respective assemblies, the ring elements being outer bodies having spaced endless scallop guides, each scallop guide having unequal numbers of scallops and the guides being adapted to receive sets of planet
25 rollers of the planet carrier elements, the second rotating elements being planet carrier elements of the respective assemblies, the planet carrier elements housing spaced sets of rollers of unequal numbers of rollers corresponding to the planets of each assembly, the rollers bridging between the scallop guides of the outer bodies and the third elements of the assemblies, the planet carrier elements being

constrained by a rotation blocking means allowing rotation in one direction and a controlled rotation in the other direction, the third elements of the assemblies being sun elements in the form of respective cams, the third element of the second element assembly being constrained to rotate at a respective fixed gear ratio relative to an
5 input to the Variable Ratio Multi-gear, the control means being operable to supply a variable rotation to the first element of the second assembly across a continuous range of output gear ratios between low and high angular velocities at respective predetermined low and high output angular velocities.

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AMENDED CLAIMS

[received by the International Bureau on 16 July 2002 (16.07.02);
original claims 1-5 replaced by new claims 1-21 (11 pages)]

1. A Variable Ratio Multi-gear having at least one input and one output and being of the epicyclic type involving interaction of three mechanically distinct rotating elements with any suitable form that allows the transfer of torque between input and output,
- 5 namely a sun element, a ring element and a planet element in each of at least first and second unequal co-axial epicyclic assemblies, a first element of the first assembly and a first element of the second assembly able to rotate independently, a second rotating element of the first assembly and a second rotating element of the second assembly being constrained to rotate at a common angular velocity, a third
- 10 element of the first assembly being connected to a motive source, and control means for progressively changing the gear ratio applied to a load connected to the first element of the first assembly of the Variable Ratio Multi-gear characterised in that the first and second assemblies each represent unequal fixed gear ratios respectively between the input and the output of the Variable Ratio Multi-gear, the first and
- 15 second assemblies arranged so that if individually each assembly has their first element constrained and their third element rotated in a certain direction the second element will tend to rotate in an opposite direction relative to the tendency of the other assembly, the control means being operative to progressively increase or decrease the output gear ratio in accordance with the demand for an output lower or
- 20 higher gear stage of operation.
2. The Variable Ratio Multi-gear according to claim 1 wherein the first elements are the ring elements of the respective assemblies, the ring elements being outer bodies having spaced endless scallop guides being adapted to receive sets of planet elements being in the form of rollers, the second rotating elements comprising of
- 25 planet carrier elements and planet elements, the planet carrier elements of the respective assemblies constrained to rotate about an axis collinear with the axes of their respective third elements, the planet carrier elements locating and controlling the motion of integral spaced sets of rollers corresponding to the planet elements of

each assembly, the rollers bridging between the scallop guides of the outer bodies and the third elements of the assemblies, the planet carrier elements being constrained by a rotation controlling means allowing free rotation in one direction and a controlled rotation in the other direction, the third elements of the assemblies being
5 sun elements in the form of respective cams.

3. The Variable Ratio Multi-gear according to claim 1 wherein the first elements are the ring elements of the respective assemblies, the second rotating elements comprising of planet carrier elements and planet elements, the planet carrier elements of the respective assemblies constrained to rotate about an axis collinear
10 with the axes of their respective third elements, the planet elements constrained to rotate on their own axes with the axes being constrained to rotate with the planet carrier element, the planet elements with their axes offset from their respective planet carrier element so as to bridge individually or in combination with other planet elements between the ring element and the third element of their respective
15 assembly, the planet carrier elements being constrained by a rotation controlling means allowing free rotation in one direction and a controlled rotation in the other direction, the third elements of the assemblies being sun elements, the ring and planet and sun elements being in a form that will allow the transfer of torque at a fixed ratio between elements.

20 4. The Variable Ratio Multi-gear according to claim 2 wherein the first elements are the ring elements of the respective assemblies, the ring elements being outer bodies having spaced endless scallop guides being adapted to receive sets of planet elements being in the form of rollers, the second rotating elements comprising of planet carrier elements and planet elements, the planet carrier elements of the
25 respective assemblies constrained to rotate about an axis collinear with the axes of their respective third elements, the planet carrier elements locating and controlling the motion of integral spaced sets of rollers corresponding to the planet elements of each assembly, the rollers bridging between the scallop guides of the outer bodies and the third elements of the assemblies, the planet carrier elements being

constrained by a rotation controlling means allowing free rotation in one direction and a controlled rotation in the other direction, the third elements of the assemblies being sun elements in the form of respective cams, the control means being operable to supply a variable rotation to the third element of the second assembly across a continuous range of output gear ratios between low and high angular velocities at respective predetermined low and high output angular velocities.

5 5. The Variable Ratio Multi-gear according to claim 3 wherein the first elements are the ring elements of the respective assemblies, the second rotating elements comprising of planet carrier elements and planet elements, the planet carrier elements of the respective assemblies constrained to rotate about an axis collinear with the axes of their respective third elements, the planet elements constrained to rotate on their own axes with the axes being constrained to rotate with the planet carrier element, the planet elements with their axes offset from their respective planet carrier element so as to bridge individually or in combination with other planet elements between the ring element and the third element of their respective assembly, the planet carrier elements being constrained by a rotation controlling means allowing free rotation in one direction and a controlled rotation in the other direction, the third elements of the assemblies being sun elements, the ring and planet and sun elements being in a form that will allow the transfer of torque at a fixed ratio between elements, the control means being operable to supply a variable rotation to the third element of the second assembly across a continuous range of output gear ratios between low and high angular velocities at respective predetermined low and high output angular velocities.

25 6. The Variable Ratio Multi-gear according to claim 2 wherein the first elements are the ring elements of the respective assemblies, the ring elements being outer bodies having spaced endless scallop guides being adapted to receive sets of planet elements being in the form of rollers, the second rotating elements comprising of planet carrier elements and planet elements, the planet carrier elements of the respective assemblies constrained to rotate about an axis collinear with the axes of

their respective third elements, the planet carrier elements locating and controlling the motion of integral spaced sets of rollers corresponding to the planet elements of each assembly, the rollers bridging between the scallop guides of the outer bodies and the third elements of the assemblies, the planet carrier elements being

5 constrained by a rotation controlling means allowing free rotation in one direction and a controlled rotation in the other direction, the third elements of the assemblies being sun elements in the form of respective cams, the first element of the second assembly constrained to a fixed frame of reference, a third element of the second assembly rotating at a controlled angular velocity the control means being operative

10 to progressively increase or decrease the output gear ratio in accordance with the demand for an output lower or higher gear stage of operation.

7. The Variable Ratio Multi-gear according to claim 3 wherein the first elements are the ring elements of the respective assemblies, the second rotating elements comprising of planet carrier elements and planet elements, the planet carrier

15 elements of the respective assemblies constrained to rotate about an axis collinear with the axes of their respective third elements, the planet elements constrained to rotate on their own axes with the axes being constrained to rotate with the planet carrier element, the planet elements with their axes offset from their respective planet carrier element so as to bridge individually or in combination with other planet

20 elements between the ring element and the third element of their respective assembly, the planet carrier elements being constrained by a rotation controlling means allowing free rotation in one direction and a controlled rotation in the other direction, the third elements of the assemblies being sun elements, the ring and planet and sun elements being in a form that will allow the transfer of torque at a fixed

25 ratio between elements, the first element of the second assembly constrained to a fixed frame of reference, a third element of the second assembly rotating at a controlled angular velocity the control means being operative to progressively increase or decrease the output gear ratio in accordance with the demand for an output lower or higher gear stage of operation.

8. The Variable Ratio Multi-gear according to claim 2 wherein the first elements are the ring elements of the respective assemblies, the ring elements being outer bodies having spaced endless scallop guides being adapted to receive sets of planet elements being in the form of rollers, the second rotating elements comprising of planet carrier elements and planet elements, the planet carrier elements of the respective assemblies constrained to rotate about an axis collinear with the axes of their respective third elements, the planet carrier elements locating and controlling the motion of integral spaced sets of rollers corresponding to the planet elements of each assembly, the rollers bridging between the scallop guides of the outer bodies and the third elements of the assemblies, the planet carrier elements being constrained by a rotation controlling means allowing free rotation in one direction and a controlled rotation in the other direction, the third elements of the assemblies being sun elements in the form of respective cams, the first element of the second assembly constrained from rotating in one direction by a fixed frame of reference and free to rotate in the other direction.

9. The Variable Ratio Multi-gear according to claim 3 wherein the first elements are the ring elements of the respective assemblies, the second rotating elements comprising of planet carrier elements and planet elements, the planet carrier elements of the respective assemblies constrained to rotate about an axis collinear with the axes of their respective third elements, the planet elements constrained to rotate on their own axes with the axes being constrained to rotate with the planet carrier element, the planet elements with their axes offset from their respective planet carrier element so as to bridge individually or in combination with other planet elements between the ring element and the third element of their respective assembly, the planet carrier elements being constrained by a rotation controlling means allowing free rotation in one direction and a controlled rotation in the other direction, the third elements of the assemblies being sun elements, the ring and planet and sun elements being in a form that will allow the transfer of torque at a fixed ratio between elements, the first element of the second assembly constrained from

rotating in one direction by a fixed frame of reference and free to rotate in the other direction.

10. The Variable Ratio Multi-gear according to claim 2 wherein the first elements are the ring elements of the respective assemblies, the ring elements being outer
5 bodies having spaced endless scallop guides being adapted to receive sets of planet elements being in the form of rollers, the second rotating elements comprising of planet carrier elements and planet elements, the planet carrier elements of the respective assemblies constrained to rotate about an axis collinear with the axes of their respective third elements, the planet carrier elements locating and controlling
10 the motion of integral spaced sets of rollers corresponding to the planet elements of each assembly, the rollers bridging between the scallop guides of the outer bodies and the third elements of the assemblies, the planet carrier elements being constrained by a rotation controlling means allowing free rotation in one direction and a controlled rotation in the other direction, the third elements of the assemblies being
15 sun elements in the form of respective cams, the third element of the second assembly being constrained to rotate at a respective fixed gear ratio relative to an input to the Variable Ratio Multi-gear, the control means being operable to supply a variable rotation to the first element of the second assembly across a continuous range of output gear ratios between low and high angular velocities at respective
20 predetermined low and high output angular velocities.

11. The Variable Ratio Multi-gear according to claim 3 wherein the first elements are the ring elements of the respective assemblies, the second rotating elements comprising of planet carrier elements and planet elements, the planet carrier
elements of the respective assemblies constrained to rotate about an axis collinear
25 with the axes of their respective third elements, the planet elements constrained to rotate on their own axes with the axes being constrained to rotate with the planet carrier element, the planet elements with their axes offset from their respective planet carrier element so as to bridge individually or in combination with other planet elements between the ring element and the third element of their respective

assembly, the planet carrier elements being constrained by a rotation controlling means allowing free rotation in one direction and a controlled rotation in the other direction, the third elements of the assemblies being sun elements, the ring and planet and sun elements being in a form that will allow the transfer of torque at a fixed ratio between elements, the third element of the second assembly being constrained to rotate at a respective fixed gear ratio relative to an input to the Variable Ratio Multi-gear, the control means being operable to supply a variable rotation to the first element of the second assembly across a continuous range of output gear ratios between low and high angular velocities at respective predetermined low and high output angular velocities.

12. The Variable Ratio Multi-gear according to claim 2 wherein the first elements are the ring elements of the respective assemblies, the ring elements being outer bodies having spaced endless scallop guides being adapted to receive sets of planet elements being in the form of rollers, the second rotating elements comprising of planet carrier elements and planet elements, the planet carrier elements of the respective assemblies constrained to rotate about an axis collinear with the axes of their respective third elements, the planet carrier elements locating and controlling the motion of integral spaced sets of rollers corresponding to the planet elements of each assembly, the rollers bridging between the scallop guides of the outer bodies and the third elements of the assemblies, the planet carrier elements being constrained by a rotation controlling means allowing free rotation in one direction and a controlled rotation in the other direction, the third elements of the assemblies being sun elements in the form of respective cams, the third element of the second assembly being constrained to rotate at a respective fixed gear ratio relative to an input to the Variable Ratio Multi-gear, the flow of a suitably formulated fluid or gas or like due to the action of the first element of the second assembly against a fixed frame of reference being directed and controlled in two circuits, the flow of said suitably formulated fluid or gas or like from the said first element of the second assembly in the first circuit being directed and controlled towards the contracting

spaces on one side of the rollers of the first assembly so as to tend to restrict the movement of the rollers within the scallops of the first element of the first assembly, the flow of said suitably formulated fluid or gas or like in the second circuit being directed and controlled towards a part of the Variable Ratio Multi-gear that provides a low resistance to flow, the progressive control of the amount of flow of the said suitably formulated fluid or gas or like in the first and second circuits operable to progressively change the gear ratio applied to a load connected to the first element of the first assembly of the Variable Ratio Multi-gear.

13. The Variable Ratio Multi-gear according to claim 10 wherein energy can be transferred to the suitably formulated fluid or gas or like and stored internally or externally so as to enable the return of the energy to the load when required.

14. The Variable Ratio Multi-gear according to claim 2 wherein the first elements are the ring elements of the respective assemblies, the ring elements being outer bodies having spaced endless scallop guides being adapted to receive sets of planet elements being in the form of rollers, the second rotating elements comprising of planet carrier elements and planet elements, the planet carrier elements of the respective assemblies constrained to rotate about an axis collinear with the axes of their respective third elements, the planet carrier elements locating and controlling the motion of integral spaced sets of rollers corresponding to the planet elements of each assembly, the rollers bridging between the scallop guides of the outer bodies and the third elements of the assemblies, the planet carrier elements being constrained by a rotation controlling means allowing free rotation in one direction and a controlled rotation in the other direction, the third elements of the assemblies being sun elements in the form of respective cams, the rotation of the third elements causing motion of the second rotating elements, the motion of the second and third elements causing contracting and expanding spaces, the contracting spaces in the first assembly displacing a suitably formulated fluid or gas or like, the displaced fluid or gas or like being directed into and controlled in two circuits, the control means proportioning the flow of said suitably formulated fluid or gas or like in the said two

circuits in accordance with the demand for an output lower or higher gear stage of operation, the flow of said suitably formulated fluid or gas or like in the first circuit being used to rotate the third element of the second assembly, the flow of said suitably formulated fluid or gas or like in the second circuit being directed and
5 controlled towards a part of the Variable Ratio Multi-gear that provides a low resistance to flow, the suitably formulated fluid or gas or like being drawn into the expanding spaces of the first assembly in a controlled manner after completing the first or second circuits, the progressive control of the amount of flow of the said suitably formulated fluid or gas or like in the first and second circuits operable to
10 progressively change the gear ratio applied to a load connected to the first element of the first assembly of the Variable Ratio Multi-gear.

15 15. The Variable Ratio Multi-gear according to claim 12 wherein energy can be transferred to the suitably formulated fluid or gas or like and stored internally or externally so as to enable the return of the energy to the load when required.

16. The Variable Ratio Multi-gear according to claim 1 wherein the axis of the input or inputs are collinear with the axis of the third element of the first assembly, the axis of the output or outputs are collinear with the axis of the third element of the first assembly, the axis of the third elements of the first and second assemblies are collinear, the elements of both assemblies supported directly or indirectly by the fixed
20 frame of reference, the motive source supported directly or indirectly by the fixed frame of reference, the reactive torque from the motive source acting on the fixed frame of reference.

17. The Variable Ratio Multi-gear according to claim 1 wherein the axis of the inputs are collinear with the axis of the third element of the first assembly, the axis of
25 the output or outputs are collinear with the axis of the third element of the first assembly, the axis of the third elements of the first and second assemblies are collinear, the elements of both assemblies supported directly or indirectly by the fixed frame of reference, a motive source supported directly or indirectly by the fixed frame of reference and connected to the third element of the first assembly, another motive

source supported directly or indirectly by the fixed frame of reference and connected to the third element of the second assembly, the reactive torques from the motive sources acting on the fixed frame of reference.

18. The Variable Ratio Multi-gear according to claim 1 wherein the axis of the
5 inputs are collinear with the axis of the third element of the first assembly, the axis of the output or outputs are collinear with the axis of the third element of the first assembly, the axis of the third elements of the first and second assemblies are collinear, the elements of both assemblies supported directly or indirectly by the fixed frame of reference, an input driven by external influences such as wind connected to
10 the third element of the first assembly, another input source driven by external influences and connected to the third element of the second assembly.

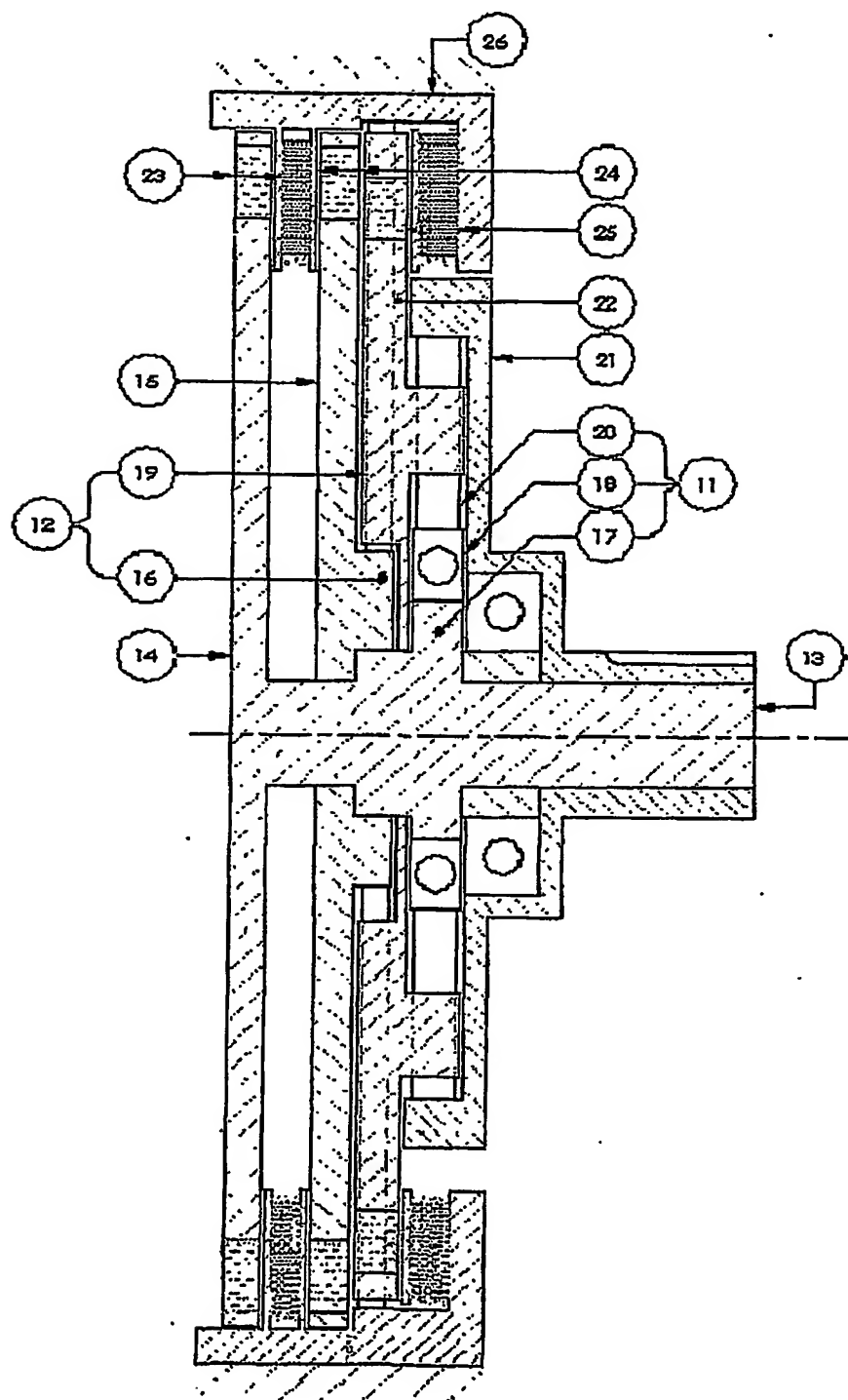
19. A Variable Ratio Multi-gear having an input and two contra-rotating outputs and being of the epicyclic type involving interaction of three mechanically distinct rotating elements with any suitable form that allows the transfer of torque between input and
15 output, namely a sun element, a ring element and a planet element being in each of at least first, second and third co-axial epicyclic assemblies, a second rotating element of the first assembly and a second rotating element of the second assembly being constrained to rotate at a common angular velocity, the first element of the first assembly and the first element of the third assembly being constrained to rotate at a
20 common angular velocity, and control means for progressively changing the gear ratio applied to a load connected to the first element of the first and third assemblies and another load connected to the second element of the third assembly of the Variable Ratio Multi-gear characterised in that the first and second assemblies each represent unequal fixed gear ratios respectively between the input and the output of
25 the Variable Ratio Multi-gear the first and second assemblies arranged so that if individually each assembly has their first element constrained and their third element rotated in a certain direction the second element will tend to rotate in an opposite direction relative to the tendency of the other assembly, the third assembly arranged so that if individually it's first element is constrained and the third element rotated in

the same certain direction of the first and second assemblies the second element will tend to rotate in the same direction as the second assembly, the control means being operative to progressively increase or decrease the output gear ratios in accordance with the demand for an output lower or higher gear stage of operation.

20. The Variable Ratio Multi-gear according to claim 1 wherein more elements can be included to provide over-drive and reversing features.

21. The Variable Ratio Multi-gear according to claim 1 wherein the rotation controlling and blocking means required, and where over-running

requirements are needed can be of any type, such as simple ratchets, one way clutches, sprag clutches where required and can be reversible, controllable, releasable, remote controllable, with stepping abilities and can be replaced by electro-magnetic drives and electro-magnetic fields and clutches, and hydraulic manipulation, as also with centrifugal clutching of any type, able to be integrated, as well as with liquid polymer control and clutching, these being able to operate automatically and with manual over-ride abilities where chosen.

Fig. 1

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU02/00305

A. CLASSIFICATION OF SUBJECT MATTER		
Int. Cl. ⁷ : F16H 3/72, 3/62, 25/06		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) DWPI: IPC: F16H 3/72, 3/62, 25/06 and keywords: continuous, progressive, infinite, stepless		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3861484A (JOSLIN) 21 January 1975	1
Y	Whole document	2-5
Y	WO 00/17542A (DEAN) 30 March 2000	2-5
	Whole document	
A	WO 98/20267A (WERRE) 14 May 1998	1
	Whole document	
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex		
* Special categories of cited documents:		
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	
"P" document published prior to the international filing date but later than the priority date claimed		
Date of the actual completion of the international search 2 May 2002	Date of mailing of the international search report 13 MAY 2002	
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929	Authorized officer KURT TOBLER Telephone No : (02) 6283 2469	

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU02/00305

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5213551A (ANTONOV) 25 May 1993 Whole document	
A	US 4295391A (PHILPOTT et al.) 20 October 1981 Whole document	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU02/00305

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report			Patent Family Member		
US	3861484	NONE			
WO	9820267	AU 51005/98	US	5800302	
US	5213551	AU 74784/91	CA	2054740	CS 9100499
		EP 469145	FR	2658890	US 5409428
		WO 9113275	FR	2662483	
US	4295391	DE 2921981	GB	1603798	
END OF ANNEX					

PATENT
FULL

copy of spec as lodged
12 April 2001 (no amendments
2 have been made to this appl.)
COPY

A CONVERTOR

TECHNICAL FIELD OF THE INVENTION

THIS invention relates to a convertor of the epicyclic type. The present application is a divisional of parent application No. 42515/99.

5

BACKGROUND TO THE INVENTION

Epicyclic gear trains are common. Polder describes variable epicyclic gear trains in his publication "A Network Theory for Variable Epicyclic Gear Trains" published in 1969 by Greve Offset N.V. Eindhoven, Netherlands, an epicyclic gear being characterised as a black box unit with three rotating elements which are effectively able to be considered as shafts since any one may comprise an input or output, represented in a mathematical mode as a "three pole" device with one linear equation for angular velocities and two linear equations for torques.

The equation for angular velocities is written in the general form:

$$a\omega_A + b\omega_B + c\omega_C = d$$

15

where a, b, c and d are co-efficients;

A, B and C specify the respective shafts; and

and ω_A , ω_B and ω_C are the angular velocities of the shafts.

The equations for torque are derived from the equilibrium:

$$\alpha T_A + \beta T_B + \gamma T_C = 0$$

20 where α , β and γ are generally different, the two equations being derived as follows:

eliminating T_C yields the first equation:

$$\left(\frac{\alpha - \gamma}{\beta - \gamma} \right) T_A + T_B = 0$$

$\left(\frac{\alpha - \gamma}{\beta - \gamma} \right)$ is a constant which Polder replaces with $\bar{i}_{A/B} \bar{\eta}_{B/A}$ giving

$$\bar{i}_{A/B} \bar{\eta}_{B/A} T_A + T_B = 0 \quad \text{The first torque equation}$$

where $\bar{i}_{A/B} = \frac{\omega_A}{\omega_B}$ for $\omega_C = 0$ is called the "binary ratio"

$$\text{and } \bar{\eta}_{B/A} = \frac{1}{\bar{i}_{A/B}} \bar{i}_{A/B} \eta_{A/B} = \frac{\omega_B}{\omega_A} \left(\frac{-T_B}{T_A} \right) = \frac{-P_B}{P_A} \text{ for } \omega_C = 0$$

5 where P_B and P_A are shaft powers and $\bar{\eta}_{B/A}$ is referred to as the "binary efficiency".

In the case of epicyclic gears there is no distinction between shafts so suffixes can be transposed. Each consistent transposition of suffixes throughout the three formulae is called a "permutation".

10 Ternary ratios and ternary efficiencies exist for the situation of three rotating shafts these being represented by:

$$\text{ternary ratio } \hat{i}_{A/B} = \frac{\omega_A}{\omega_B}$$

$$\text{ternary efficiency } \hat{\eta}_{B/A} = \frac{-P_B}{P_A}$$

The shaft powers satisfy the equilibrium:

$$P_A + P_B + P_C + P_V = 0$$

where P_V is the dissipative power.

5 Polder's network theory of variable epicyclic gear trains involves simplifying any epicyclic gear train into an equivalent involving three pole branches, usually a combination of simple three pole transmission branches and three pole epicyclic branches.

Clearly by appropriate selection of the ratios the torque and power characterisation of any epicyclic gear train can be determined.

10 In this sense the relationships involved in an epicyclic gear train are well defined. Polder suggests a number of variable epicyclic gear trains derived using his network theory.

An object of the present invention is to provide a convertor of the epicyclic type as a useful alternative to the prior art.

15 OUTLINE OF THE INVENTION

In one aspect the invention provides a convertor having an input and an output and being of the epicyclic type involving interaction of three mechanically distinct rotating elements, namely a sun element, a ring element and a planet carrier element in each of at least first and second unequal co-axial epicyclic assemblies, a first rotating
20 element of the first assembly and a first rotating element of the second assembly being constrained to rotate at a common angular velocity, a second rotating element of the first assembly and a second rotating element of the second assembly being constrained to rotate at a common angular velocity, and control means for progressively changing the gear ratio applied to a load connected to the first rotating elements of the convertor
25 characterised in that the first rotating elements are unequal pairs of the same

mechanical elements of the respective assemblies and in conjunction with respective second rotating elements each represent different respective fixed gear ratios relative to the input and the output of the convertor, the second rotating elements are unequal pairs of the same mechanical elements of the respective assemblies and in conjunction with respective said first rotating elements each represent fixed gear ratios between the input and the output of the convertor, a third element of the second assembly rotating in response to demand for an output low gear stage of operation of the convertor and the control means being operative to progressively increase the output gear ratio and at the same time slow the rotation of the third element in accordance with demand for an output higher gear stage of operation, the control means being operative to increase or decrease the output gear ratio automatically in accordance with the said demand.

In the description "output higher gear stage of operation" means "higher" in the sense of a gear ratio approaching 1:1 ratio as input to output, while "output low gear stage of operation" means an output gearing in the opposite sense generally corresponding to a lower output angular velocity.

The first rotating elements are typically the ring elements of the respective assemblies. The ring elements are preferably outer bodies having spaced endless scollop guides, each scollop guide having unequal relative numbers of scollops to rollers in either side depending on the required gear ratios for a particular application and the guides being adapted to receive sets of planet rollers of the planet carrier elements.

The second rotating elements are typically the planet carrier elements of the respective assemblies. The planet carrier elements are typically formed as an integral unit housing spaced sets of rollers of unequal numbers relative to the number of scollops, with the rollers corresponding to the planets of each assembly, the rollers bridging between the scollop guides of the outer bodies and the third elements of the assemblies. The planet carrier is preferably constrained by a rotation blocking means

to travel in one direction only. The rotation blocking means is preferably a selective rotation blocking means enabling selection of rotation of the second rotating elements in forward or reverse direction.

5 The third elements of the assemblies are preferably sun elements in the form of respective cams, each cam typically having a roller bearing assembly separating the cam into an inner cam and a cam ring able to travel opposite the direction of the inner cam.

The control means is typically a centrifugal clutch operable to slip to partially engage the third element of the second assembly across a continuous range of output gear ratios between fully disengaged and fully engaged positions of the centrifugal clutch at respective predetermined low and high output angular velocities.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a section corresponding to Fig 4A of the parent application 42515/99; and

15 Figure 2 a section corresponding to Figure 6 of parent application 42515/99

METHOD OF PERFORMANCE

Referring to the drawings there are illustrated in Figure 1 and Figure 2 two convertors employing the same general configuration in that both have an epicyclic unit or module shown collectively in relation to the components concerning numerals 10 in Figure 2 and the numerals 11 and 12 in Figure 1 and shown here in preferred form and the inclusion of this module to all embodiments being the central concept of the present invention. In the example illustrated in Figure 1, the module employs first and second unequal co-axial epicyclic assemblies 11 and 12, these are both of the cycloidal type, that is, employing scollops and rollers.

While each module is shown generally with the numerals 10,11 and 12 in Figures 1 and 2 the particular module used in each case differs in terms of specific arrangement due to the different applications.

Modules employed will vary in specific arrangement for other applications as well. What is common is that each of the assemblies 10, 11, 12 share a common planet element and a common ring element. The sun elements are separate cams, rollers bridge between the cams and the scallops. The planet element comprises a planet carrier bridging axially between the assemblies having opposite sides which are unequal in terms of the number of rollers relative to the number of scallops carried by the planet carrier, while the ring element comprises an outer body having scallops arranged so the assemblies each represent different fixed ratios relative to an input and an output.

This means the planet carriers of the two assemblies are constrained to rotate at the same angular velocity. It also means that the outer bodies of the two assemblies are constrained to rotate at the same angular velocity. In the illustrated embodiments the angular velocity of the outer body could be zero.

In each assembly the cams are eccentric cams which rotate in co-operation with the scallops and roller configuration of the respective assemblies. One of the cams is driven by an input shaft, this will cause the output, that is the outer body, to rotate while the other cam rotates in the opposite direction. The output gear ratio is influenced by the angular velocity of the second cam, thus various braking arrangements applied to the second cam will influence the output in a controllable fashion according to demand.

While the above description deals with the general features involved the following description will enable understanding of the application of the invention to the two specific applications of Figure 1 and Figure 2.

Figure 1 shows a convertor according to the invention an input, which is a rotor (14) an output (21) and electrical coil and permanent magnet arrangements (23 - 25)

that apply torques respectively to rotors (14, 15) and a planet element in the form of a cage (22).

Items 23, 24 and 25 are arrangements of permanent magnets and electrical coils so that with electricity flowing through the coils, interacting magnetic fields are produced which cause a torque on the rotors (14, 15) and cage (22) respectively. The electricity supply can be adjusted individually for each of items 23 to 25.

The rotor (14) and input shaft (13) are combined as an integrated part in this module. As an alternative, the rotor (14) could be removed and the input could be solely from an external motive source driving the input shaft (13). The point is the module comprising the groupings 11 and 12 remains the same.

Assembly 11 is the first unequal coaxial assembly and comprises of a cam {sun-element} (17), bearing (18) and rollers {planet-element} (20). The cam (17) is fixed to the input shaft (13), which is therefore fixed to the input. The bearing (18) has an inner sleeve fitted to the outer diameter of the cam (17). The bearing has an outer sleeve, the outer sleeve of the bearing (18) makes contact with the rollers (20). As the input rotates, the cam (17) causes the bearing (18) to move in an eccentric fashion. This causes the rollers (20) to be cyclically displaced away and towards the central axis of the convertor, the total displacement relative to this central axis, being twice the cam axis offset from this axis. The rollers (20) are located in equally spaced guides in the cage {planet element} (22). The rollers (20) make contact with scallops in the output {ring element} (21). For both assemblies (11 & 12), the number of scallops relative to the number rollers in contact with the scallops, determines the direction of rotation it would rotate the output (21) if the cage (22) was held still. One more scallop than the number of rollers gives an output rotation direction the same as the cam rotation. One less scallop than the number of rollers would give an output rotation the opposite to the cam rotation. The scallops are so shaped that as the rollers are acted on by the cam, the

scallops rotate relative to the cage at a constant angular velocity ratio to that of the cam. The action between the cam (17), bearing (18) and rollers (20) against the output (21), causes an equal and opposite reaction on the cage (22), tending to rotate it in the opposite direction to the rotation of the output (21). The cage (22) is constrained by a rotation blocking means in such a way as to allow the cage (22) to only rotate in a direction the same as the output (21). Therefore because of the reactive forces, the cage (22) will be held against the rotation blocking means and will therefore be stationary relative to the frame (26) with just the actions of assembly 11 alone. The magnetic effects caused by items 25 can drive the cage (22) (with the same action as 23 does on item 14). This torque caused by items 25 is an ancillary action and not necessary for the central concept of the present invention. The rollers will rotate about their own axis as they move in relation to the scallops. The bearing (18), is added to eliminate the sliding action of roller (20) against cam (17), which would occur (if they were in direct contact) because of the difference in their circumferential speeds. The output (21) is constrained to rotate about the central axis of the input shaft (13). The cyclical movement of the rollers (20) acting on the scallops alone, causes the output (21) to rotate at a reduced rotational speed depending on the number of rollers and scallops.

For example, if the cage (22) is constrained from being able to rotate, and if assembly 11 has four rollers (20), and there are five scallops in the output (21), the ratio would be one output (21) revolution for every five revolutions of the cam (17) with the output (21) rotating in the same direction as the cam (17).

Assembly 12 is the second unequal coaxial assembly and comprises of a rotor (15), cam (16), and rollers (19). The scallops in the output (21) make contact with the rollers (19) which make contact with the cam (16). The cam (16) is fixed to the rotor (15). To reduce frictional losses, a bearing would be fitted to the outside diameter of the

cam (16). The number of scallops and rollers for assembly 12 are different to the numbers for assembly 11. The rollers are located in equally spaced guides in the cage (22). The cage therefore bridges axially between assemblies 11 and 12 and the rollers (19) are constrained to rotate at the same angular velocity about the central axis of the input shaft (13) as the rollers (20) of assembly 11. The numbers of scallops and rollers are such that if the cage (22) is held relative to the frame (26), the output (21) tends to cause the cam (16) to rotate with an angular velocity in the opposite direction to cam (17).

For example, if the cage (22) is constrained from being able to rotate, and if assembly 12 has four rollers (20), and there are three scallops in the output (21), the ratio would be one output (21) revolution for every three revolutions of the cam (16), with the output (21) rotating in the opposite direction to the cam (16).

If the assembly 11 cam (17) is caused to rotate, the output (21) will rotate at another angular velocity, being a fixed ratio to the input angular velocity. The assembly 12 cam (16) will rotate at an angular velocity dependent on the fixed ratio of assembly 12, and for the central concept of the present invention, in the opposite direction to cam (17). If assembly 12 was arranged so that cam (16) rotated in the same direction as cam (17), the output would be reversed if cam (16) was braked. The cam (16) will have no effect on the output angular velocity until the electrical coils of items 24 are activated.

With the electrical coils activated, a torque is transmitted through the rotor (15) to the cam (16). The electrical coils could be activated so that the torque acts in the same or opposite direction as the rotation of the cam (16). If the torque acts in the same direction as the rotation of the cam (16), the output would rotate at the angular velocity determined by the fixed ratio but with an increased torque dependant on the amount of torque contributed by items 24. The torque from items 24 act in the opposite direction of rotation of the cam (16) (ie. the same direction as the input shaft (13)). In this case,

assembly 12 will act so as to try and cause the output (21), to rotate in the opposite direction and the cage (22) in the same direction as the input. In simplistic terms, the opposite actions on the output and cage caused by cam (16) tend to 'lock' the cage (22) to the input rotation. The cage (22) is free to rotate in the direction of the input (cam (17)). The cage (22) therefore tends to cause the output (21) to rotate as one with the input. The rollers (20) rotation about the central axis of the input shaft (13) due to the action of the cam (17), has superimposed on it a rotation about this central axis due to the rotation of the cage (22) in the direction of the input. It is this superimposed rotation that causes the output to increase its angular velocity relative to the input angular velocity. The amount of rotation of the cage (22) and therefore the amount of superimposed rotation, is determined by the relative differences in the output resistive torque (hereafter called the 'load') and the input torque from cam (17) and items 24. When the 'load' lowers relatively and the torque from items 24 is increased, the less the torque required from cam (17). As the proportion of torque from cam (16) relative to cam (17) increases, the more the output (21) tends to be 'locked' to the input and the more the ratio of input to output angular velocity tends to approach 1:1. The output gear ratio therefore can be progressively decreased from the fixed ratio of the first assembly to a 1:1 ratio by progressively increasing the torque acting on the cam (16) from zero to a value that causes the cage (22) to be 'locked' fully to the input. The output torque is inversely proportional to the output angular velocity.

Figure 2 shows another embodiment of a convertor, in this case there is a combination of a module 10 with extensions (on the right-hand half) that enable further multiple fixed ratios to be obtained from the one convertor. The module 10 shows the central concept of the present invention. The input is via a separate motive source (not shown) acting through the input shaft (13). The output is the ring element or body (21).

The first unequal coaxial assembly comprises of a cam {sun-gear} (17), and rollers {planet-gears} (20) and the ring element or body (21). The cam (17) is fixed to the input shaft (13). The outer diameter of the cam (17) makes contact with the rollers (20). As the input rotates, the cam (17) outer diameter moves in an eccentric fashion.

5 This causes the rollers (20) to be cyclically displaced away and towards the central axis of the convertor, the total displacement relative to this central axis, being twice the cam axis offset from this axis. The rollers (20) are located in equally spaced guides in the cage {planet carrier} (22). The rollers (20) make contact with scallops in the output (21). For both assemblies (11 & 12), the number of scallops relative to the number rollers in

10 contact with the scallops, determines the direction of rotation it would rotate the output (21) if the cage (22) was held still. One more scallop than the number of rollers gives an output rotation direction the same as the cam rotation. One less scallop than the number of rollers would give an output rotation the opposite to the cam rotation. The scallops are so shaped that as the rollers are acted on by the cam, the scallops rotate

15 relative to the cage at a constant angular velocity ratio to that of the cam. The action between the cam (17), bearing (18) and rollers (20) against the output (21), causes an equal and opposite reaction on the cage (22), tending to rotate it in the opposite direction to the rotation of the output (21). The cage (22) is constrained by a rotation blocking means in such a way as to allow the cage (22) to only rotate in a direction the

20 same as the output (21). Therefore because of the reactive forces, the cage (22) will be held against the rotation blocking means and will therefore be stationary relative to the frame (the structure holding mounting the motor etc.) with just the actions of assembly 11 alone. The rollers will rotate about their own axis as they move in relation to the scallops. A bearing could be fitted to the outside diameter of the cams (16 & 17) to

25 eliminate the sliding action of roller (19 & 20) against cam (16 & 17), which would occur (if they were in direct contact) because of the difference in their circumferential speeds.

The output (21) is constrained to rotate about the central axis of the input shaft (13). The cyclical movement of the rollers (20) acting on the scallops alone, causes the output (21) to rotate at a reduced rotational speed depending on the number of rollers and scallops.

5 For example, if the cage (22) is constrained from being able to rotate, and if assembly 11 has four rollers (20), and there are five scallops in the output (21), the ratio would be one output (21) revolution for every five revolutions of the cam (17) with the output (21) rotating in the same direction as the cam (17).

 The second unequal coaxial assembly comprises of a cam (16), and rollers (19)
10 and the output (21). The scallops in the output (21) make contact with the rollers (19) which make contact with the cam (16). The number of scallops and rollers for the assembly are different to the first assembly 11. The rollers are located in equally spaced guides in the cage (22). The cage therefore bridges axially between assemblies 11 and 12 and the rollers (19) are constrained to rotate at the same angular velocity about the
15 central axis of the input shaft (13) as the rollers (20) of assembly 11. The numbers of scallops and rollers are such that if the cage (22) is held relative to the frame, the output (21) tends to cause the cam (16) to rotate with an angular velocity in the opposite direction to cam (17).

 For example, if the cage (22) is constrained from being able to rotate, and if
20 assembly 12 has four rollers (20), and there are three scallops in the output (21), the ratio would be one output (21) revolution for every three revolutions of the cam (16), with the output (21) rotating in the opposite direction to the cam (16).

 If the assembly 11 cam (17) is caused to rotate, the output (21) will rotate at another angular velocity, being a fixed ratio to the input angular velocity. The assembly
25 12 cam (16) will rotate at an angular velocity dependent on the fixed ratio of assembly 12, and for the central concept of the present invention, in the opposite direction to cam

(17). If assembly 12 was arranged so that cam (16) rotated in the same direction as cam (17), the output would be reversed if cam (16) was braked. The cam (16) will have no effect on the output angular velocity until a torque is made to act on it. Any torque acting on cam (16) could act in the same or opposite direction as the rotation of the cam

5 (16). If the torque acts in the same direction, the output would rotate at the angular velocity determined by the fixed ratio but with an increased torque. As in the previous embodiment the torque acting on cam (16) is in a direction opposite to that of the rotation of the cam (16) (ie. the same direction as the input shaft (13)). In this case, assembly 12 will act so as to try and cause the output (21), to rotate in the opposite

10 direction and the cage (22) in the same direction as the input. In simplistic terms, the opposite actions on the output and cage caused by cam (16) tend to 'lock' the cage (22) to the input rotation. The cage (22) is free to rotate in the direction of the input (cam (17)). The cage (22) therefore tends to cause the output (21) to rotate as one with the input. The rollers (20) rotation about the central axis of the input shaft (13) due to the

15 action of the cam (17), has superimposed on it a rotation about this central axis due to the rotation of the cage (22) in the direction of the input. It is this superimposed rotation that causes the output to increase its angular velocity relative to the input angular velocity. The amount of rotation of the cage (22) and therefore the amount of superimposed rotation, is determined by the relative differences in the output resistive

20 torque (hereafter called the 'load') and the input torque from the cams (17 & 16). When the 'load' lowers relatively and the torque acting on cam (16) is increased, the less is the torque required from cam (17). As the proportion of torque from cam (16) relative to cam (17) increases, the more the output (21) tends to be 'locked' to the input and the more the ratio of input to output angular velocity tends to approach 1:1. The output gear

25 ratio therefore can be progressively decreased from the fixed ratio of the first assembly to a 1:1 ratio by progressively increasing the torque acting on the cam (16) from zero

to a value that causes the cage (22) to be 'locked' fully to the input. The output torque is inversely proportional to the output angular velocity.

The input torque to cam (16) can be through another motive source or a clutch mechanism connecting the input shaft (13) to the extension of cam (16). If a clutch mechanism was used, the control mechanism could be automatic and linked to the output speed through the use of a centrifugal clutch. With a centrifugal clutch arrangement, as the speed of the output increases the clutch engages and tends to turn cam (16) in the same direction as the input, cam (17). So as the output is accelerated at the lower fixed ratio, there will come a stage when the input shaft is spinning at such a speed that the centrifugal clutch starts to engage. As the centrifugal clutch engages, the output gear ratio would progressively decrease to 1:1.

With the addition of other rotation blocking means to this arrangement to constrain other parts to rotate in one direction only, there is the possibility of having sequentially selected multiple ratios with other outputs. For example if the rotation blocking means is connected to cam (16), the body (21) or cages (28), the output will be the body (21), cage (28), and cage (29) respectively. There is also the possibility of arranging the cage (22) so that it protrudes from the right-hand side of figure 2. The cam (16) extension can be also shortened so that it lies totally within the body (21) and its rotation could be controlled by various external or internal means.

Whilst the above has been given by way of illustrative example of the present invention many variations and modifications thereto will be apparent to those skilled in the art without departing from the broad ambit and scope of the invention as herein set out in the appended claims.

CLAIMS:

1. A convertor having an input and an output and being of the epicyclic type involving interaction of three mechanically distinct rotating elements, namely a sun element, a ring element and a planet carrier element in each of at least first and second unequal co-axial epicyclic assemblies, a first rotating element of the first assembly and a first rotating element of the second assembly being constrained to rotate at a common angular velocity, a second rotating element of the first assembly and a second rotating element of the second assembly being constrained to rotate at a common angular velocity, and control means for progressively changing the gear ratio applied to a load connected to the first rotating elements of the convertor characterised in that the first rotating elements are unequal pairs of the same mechanical elements of the respective assemblies and in conjunction with respective second rotating elements each represent different respective fixed gear ratios relative to the input and the output of the convertor, the second rotating elements are unequal pairs of the same mechanical elements of the respective assemblies and in conjunction with respective said first rotating elements each represent fixed gear ratios between the input and the output of the convertor, a third element of the second assembly rotating in response to demand for an output low gear stage of operation of the convertor and the control means being operative to progressively increase or decrease the output gear ratio by controlling rotation of the third element in accordance with demand for an output lower or higher gear stage of operation, the control means thereby being operative to increase or decrease the output gear ratio automatically and progressively in accordance with the said demand.
2. The convertor according to claim 1 wherein the first rotating elements are the ring elements of the respective assemblies, the ring elements being outer bodies having spaced endless scollop guides, each scollop guide having unequal numbers of scollops and the guides being adapted to receive sets of planet rollers of the planet carrier

elements, the second rotating elements being planet carrier elements of the respective assemblies, the planet carrier elements housing spaced sets of rollers of unequal numbers of rollers corresponding to the planets of each assembly, the rollers bridging between the scollop guides of the outer bodies and the third elements of the assemblies, the planet carrier elements being constrained by a rotation blocking means to travel in one direction only, the third elements of the assemblies being sun elements in the form of respective cams.

3. The convertor according to claim 1 wherein the first rotating elements are the ring elements of the respective assemblies, the ring elements being outer bodies having spaced endless scollop guides, each scollop guide having unequal numbers of scollops and the guides being adapted to receive sets of planet rollers of the planet carrier elements, the second rotating elements being planet carrier elements of the respective assemblies, the planet carrier elements housing spaced sets of rollers of unequal numbers of rollers corresponding to the planets of each assembly, the rollers bridging between the scollop guides of the outer bodies and the third elements of the assemblies, the planet carrier elements being constrained by a rotation blocking means to travel in one direction only, the third elements of the assemblies being sun elements in the form of respective cams, the control means being operable to slip to partially engage the third element of the second assembly across a continuous range of output gear ratios between fully disengaged and fully engaged positions of the centrifugal clutch at respective predetermined low and high output angular velocities.

DATED this 12th day of APRIL, 2001

MALCOLM LEONARD STEPHEN DEAN
By his Patent Attorneys
INTELLPRO

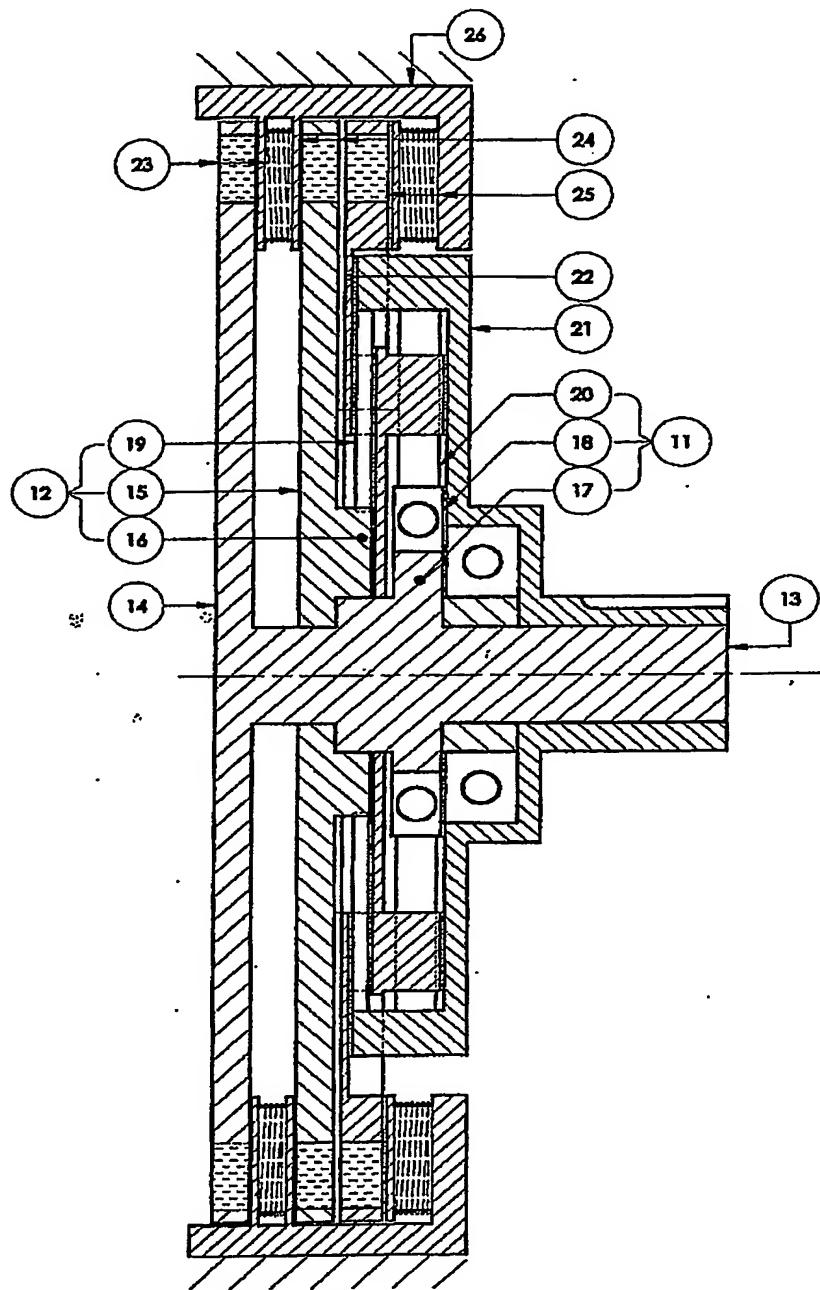


Fig. 1

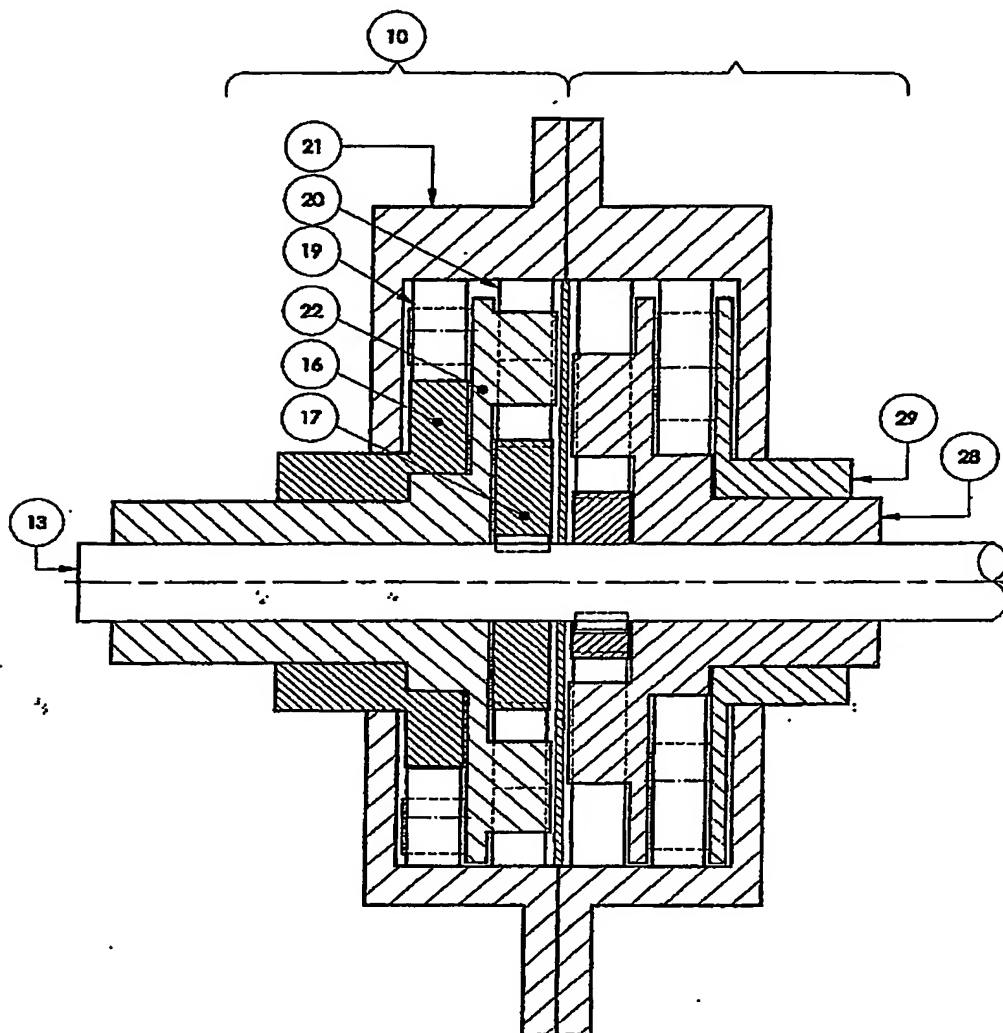


Fig 2

ABSTRACT

A module comprising the groupings 11 and 12 remains the same for all embodiments. Assemblies 11 and 12 are effectively side-by-side unequal co-axial assemblies. Assembly 11 is the first unequal coaxial assembly and comprises of a cam {sun-element} (17), bearing (18) and rollers {planet-element} (20).

Assembly 12 is the second unequal coaxial assembly and comprises of a rotor (15), cam (16), and rollers (19). The planet elements of the assemblies are constrained in the one body, the ring elements also share the one body so they are likewise constrained.

TITLE VARIABLE RATIO MULTI-GEAR

The operation of this invention is more precisely described in the first pages than the following previous description which follows on after, complete, with the added page 31/31. The same page numbers are used as the accepted amended pages of the previous patent.

These condensed description and new claims refer to this invention as a POWER CONVERTER and start with the page number 1B above.

The advancement for this invention is now shown as being with the hydraulic and gas pumping integration, such as described in the "Wheels Within Wheels" document on pages 66 to 72 item 6. It is also shown in Figs 1, 6A, 6C or 6D, in the bicycle transmission, and in the drawing Page 31/31. It is partly described in page 53, 54 together with such features as self contained accumulators, micro-processors and enormous power capabilities. The optional roller design can employ hydrostatic balancing which provides cushioning as well.

POWER CONVERTOR

TECHNICAL FIELD OF THE INVENTION

THIS invention relates to a power convertor of the epicyclic type.

BACKGROUND TO THE INVENTION

5 Epicyclic gear trains are common. Polder describes variable epicyclic gear trains in his publication "A Network Theory for Variable Epicyclic Gear Trains" published in 1969 by Greve Offset N.V. Eindhoven, Netherlands, an epicyclic gear being characterised as a black box unit with three rotating elements which are effectively able to be considered as shafts since any one may comprise an input or output, represented
10 in a mathematical mode as a "three pole" device with one linear equation for angular velocities and two linear equations for torques.

The equation for angular velocities is written in the general form:

$$a\omega_A + b\omega_B + c\omega_C = d$$

where a, b, c and d are co-efficients;

15 A, B and C specify the respective shafts; and

and ω_A , ω_B and ω_C are the angular velocities of the shafts.

The equations for torque are derived from the equilibrium:

$$\alpha T_A + \beta T_B + \gamma T_C = 0$$

where α , β and γ are generally different, the two equations being derived as follows:

20 eliminating T_C yields the first equation:

$$\left(\frac{\alpha - \gamma}{\beta - \gamma} \right) T_A + T_B = 0$$

$\left(\frac{\alpha - \gamma}{\beta - \gamma} \right)$ is a constant which Polder replaces with $\bar{i}_{A/B} \bar{\eta}_{B/A}$ giving

$$\bar{i}_{A/B} \bar{\eta}_{B/A} T_A + T_B = 0 \quad \text{The first torque equation}$$

where $\bar{i}_{A/B} = \frac{\omega_A}{\omega_B}$ for $\omega_C = 0$ is called the "binary ratio"

$$\text{and } \bar{\eta}_{B/A} = \frac{1}{\bar{i}_{A/B}} \bar{i}_{A/B} \eta_{A/B} = \frac{\omega_B}{\omega_A} \left(\frac{-T_B}{T_A} \right) = \frac{-P_B}{P_A} \text{ for } \omega_C = 0$$

5 where P_B and P_A are shaft powers and $\bar{\eta}_{B/A}$ is referred to as the "binary efficiency".

In the case of epicyclic gears there is no distinction between shafts so suffixes can be transposed. Each consistent transposition of suffixes throughout the three formulae is called a "permutation".

10 Ternary ratios and ternary efficiencies exist for the situation of three rotating shafts these being represented by:

$$\text{ternary ratio } \bar{i}_{A/B} = \frac{\omega_A}{\omega_B}$$

$$\text{ternary efficiency } \bar{\eta}_{B/A} = \frac{-P_B}{P_A}$$

The shaft powers satisfy the equilibrium:

$$P_A + P_B + P_C + P_V = 0$$

where P_V is the dissipative power.

Polder's network theory of variable epicyclic gear trains involves simplifying any
5 epicyclic gear train into an equivalent involving three pole branches, usually a
combination of simple three pole transmission branches and three pole epicyclic
branches.

Clearly by appropriate selection of the ratios the torque and power
characterisation of any epicyclic gear train can be determined.

10 In this sense the relationships involved in an epicyclic gear train are well defined.
Polder suggests a number of variable epicyclic gear trains derived using his network
theory.

An object of the present invention is to provide an a power convertor of the
epicyclic type as a useful alternative to the prior art.

15 OUTLINE OF THE INVENTION

In one aspect the invention provides a power convertor having an input and an
output and being of the epicyclic type involving interaction of three mechanically distinct
rotating elements, namely a sun element, a ring element and a planet carrier element
in each of at least first and second unequal co-axial epicyclic assemblies, a first rotating
20 element of the first assembly and a first rotating element of the second assembly being
constrained to rotate at a common angular velocity, a second rotating element of the
first assembly and a second rotating element of the second assembly being constrained
to rotate at a common angular velocity, and control means for progressively changing
the gear ratio applied to a load connected to the first rotating elements of the power
25 convertor characterised in that the first rotating elements are fixed ratio unequal pairs

of the same mechanical elements of the respective assemblies, the second rotating elements are fixed ratio unequal pairs of the same mechanical elements of the respective assemblies, the third element of the second assembly rotating in a first direction at a output-low gear stage of operation of the convertor and the control means
 5 being operative to progressively increase the output gear ratio and eventually reverse the direction of rotation of the third element of the second assembly at a predetermined output higher gear stage of operation.

The first rotating elements are typically the ring elements of the respective assemblies. The ring elements are preferably an outer bodies having spaced endless
 10 scollop guides, each scollop guide having unequal numbers of scollops depending on the required gear ratios for a particular application and the guides being adapted to receive sets of planet rollers of the planet carrier elements.

The second rotating elements are typically the planet carrier elements of the respective assemblies. The planet carrier elements are typically formed as an integral
 15 unit housing spaced sets of rollers of unequal numbers of rollers corresponding to the planets of each assembly, the rollers bridging between the scollop guides of the outer bodies and the third elements of the assemblies. The planet carrier is preferably constrained by a one way clutch to travel in one direction only.

The third elements of the assemblies are preferably sun elements in the form
 20 of respective cams, each cam typically having a roller bearing assembly separating the cam into an inner cam and a cam ring able to travel opposite the direction of the inner cam.

The control means is typically a centrifugal clutch operable to slip to partially engage the third element of the second assembly across a continuous range of output
 25 gear ratios between fully disengaged and fully engaged positions of the centrifugal clutch at respective predetermined low and high output angular velocities.

THIS ONE WAY CLUTCH
 CAN BE BETWEEN ANY
 CHOSEN COMPONENTS
 TO FRAME/GROUND

BRIEF DESCRIPTION OF DRAWINGS

Figure 4.1 shows the original left side Figure 4 of the Patent in more detail. (numbered 4A later)

Figure 4.2 shows schematically the link between the original Figure 4 and the (more current) clutch controlled design. I feel this is a very important drawing.

Figure 4.3 gives a pictorial description of how the basic four component transmission works based on the original Figure 4.

Figure 4.4 is a detail drawing of the transmission using a clutch mechanism to control the speed ratio instead of the electrical means used on the original Figure 4. This is based on Figure 4.2 (c).

Figure 4.5 and 4.6 show variations of 4.2 (c) that enables the output to be reversed.

Figure 4.7 shows other variations of Figure 4.1.

Figure 6.1 shows the original Figure 6 in more detail.

Figure 6.2 shows schematically the possible variations of Figure 6.1

Other examples of drawings are on the following pages with reference to bicycles

BRIEF DESCRIPTION OF THE DRAWINGS FOR BICYCLES

Figure 1 is an exploded view of a power convertor according to the present invention as applicable to drive train for a bicycle;

5 Figure 2 is a longitudinal section through an assembled power convertor according to figure 1;

Figure 3 is a section through 3-3 of Figure 2;

Figure 4 is a section through 4-4 of Figure 2;

Figure 5 is a section through 5-5 of Figure 2; and

10 Figure 6 is a section through 6-6 of Figure 2.

METHOD OF PERFORMANCE

Referring to the drawings and initially to Figure 1 there is illustrated a power convertor

Whilst the above has been given by way of illustrative example of the present invention many variations and modifications thereto will be apparent to those skilled in
15 the art without departing from the broad ambit and scope of the invention as herein set out in the appended claims.

Patent 88

CLAIMS

1. A power convertor having an input and an output and being of the epicyclic type involving interaction of three mechanically distinct rotating elements, namely a sun element, a ring element and a planet carrier element in each of at least first and second unequal co-axial epicycloic assemblies, a first rotating element of the first assembly and a first rotating element of the second assembly being constrained to rotate at a common angular velocity, a second rotating element of the first assembly and a second rotating element of the second assembly being constrained to rotate at a common angular velocity, and control means for progressively changing the gear ratio applied to a load connected to the first rotating elements of the power convertor characterised in that the first rotating elements are unequal pairs of the same mechanical elements of the respective assemblies and in conjunction with respective second rotating elements each represent different respective fixed gear ratios relative to the input and the output of the power convertor, the second rotating elements are unequal pairs of the same mechanical elements of the respective assemblies and in conjunction with respective said first rotating elements each represent fixed gear ratios between the input and the output of the power convertor, a third element of the second assembly rotating in response to demand for an output low gear stage of operation of the convertor and the control means being operative to progressively increase or decrease the output gear ratio by controlling rotation of the third element in accordance with demand for an output lower or higher gear stage of operation, the control means thereby being operative to increase or decrease the output gear ratio automatically and progressively in accordance with the said demand.
2. The power convertor according to claim 1 wherein the first rotating elements are the ring elements of the respective assemblies, the ring elements being outer bodies having spaced endless scollop guides, each scollop guide having unequal numbers of

scollops and the guides being adapted to receive sets of planet rollers of the planet carrier elements, the second rotating elements being planet carrier elements of the respective assemblies, the planet carrier elements housing spaced sets of rollers of unequal numbers of rollers corresponding to the planets of each assembly, the rollers
 5 bridging between the scollop guides of the outer bodies and the third elements of the assemblies, the planet carrier elements being constrained by a rotation blocking means to travel in one direction only, the third elements of the assemblies being sun elements in the form of respective cams.

3. The power convertor according to claim 1 wherein the first rotating elements are
 10 the ring elements of the respective assemblies, the ring elements being outer bodies having spaced endless scollop guides, each scollop guide having unequal numbers of scollops and the guides being adapted to receive sets of planet rollers of the planet carrier elements, the second rotating elements being planet carrier elements of the respective assemblies, the planet carrier elements housing spaced sets of rollers of
 15 unequal numbers of rollers corresponding to the planets of each assembly, the rollers bridging between the scollop guides of the outer bodies and the third elements of the assemblies, the planet carrier elements being constrained by a rotation blocking means to travel in one direction only, the third elements of the assemblies being sun elements in the form of respective cams, the control means being operable to slip to partially
 20 engage the third element of the second assembly across a continuous range of output gear ratios between fully disengaged and fully engaged positions of the centrifugal clutch at respective predetermined low and high output angular velocities.

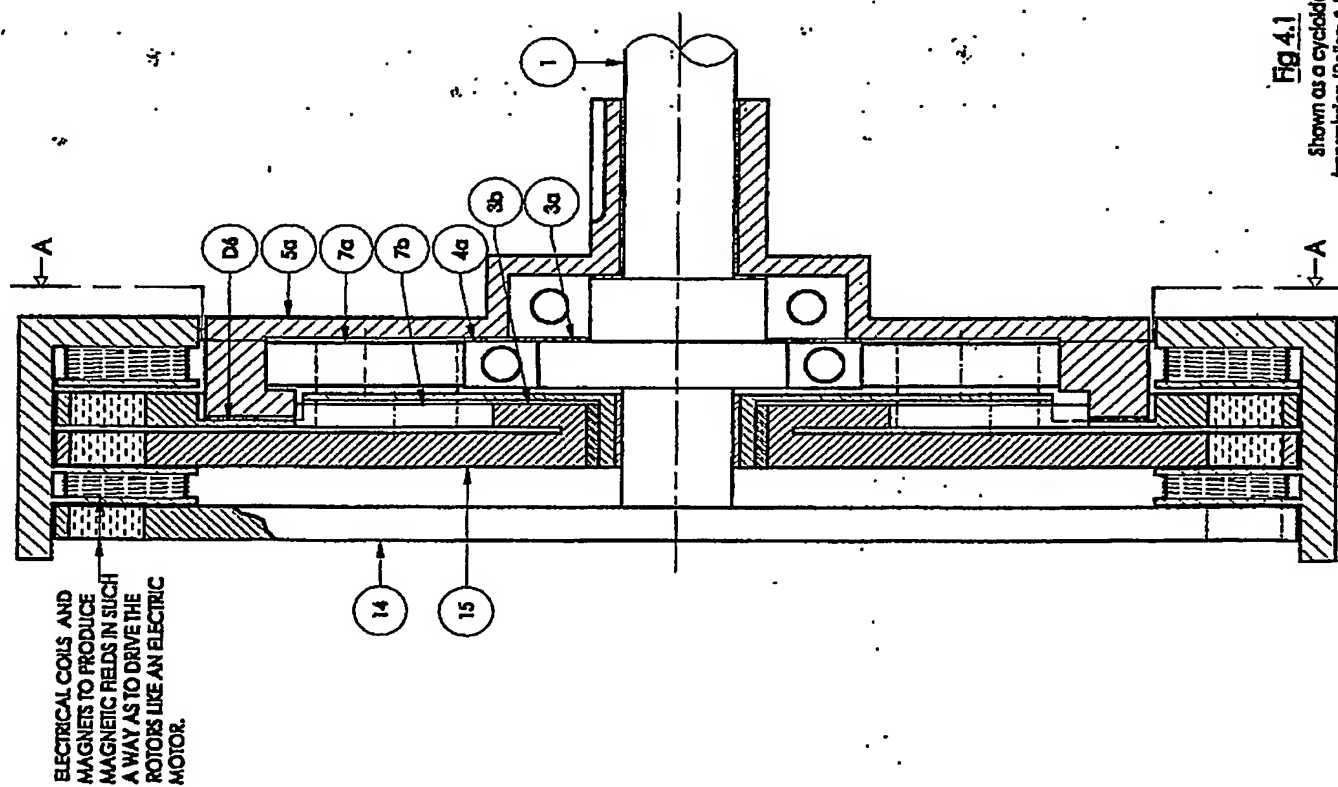
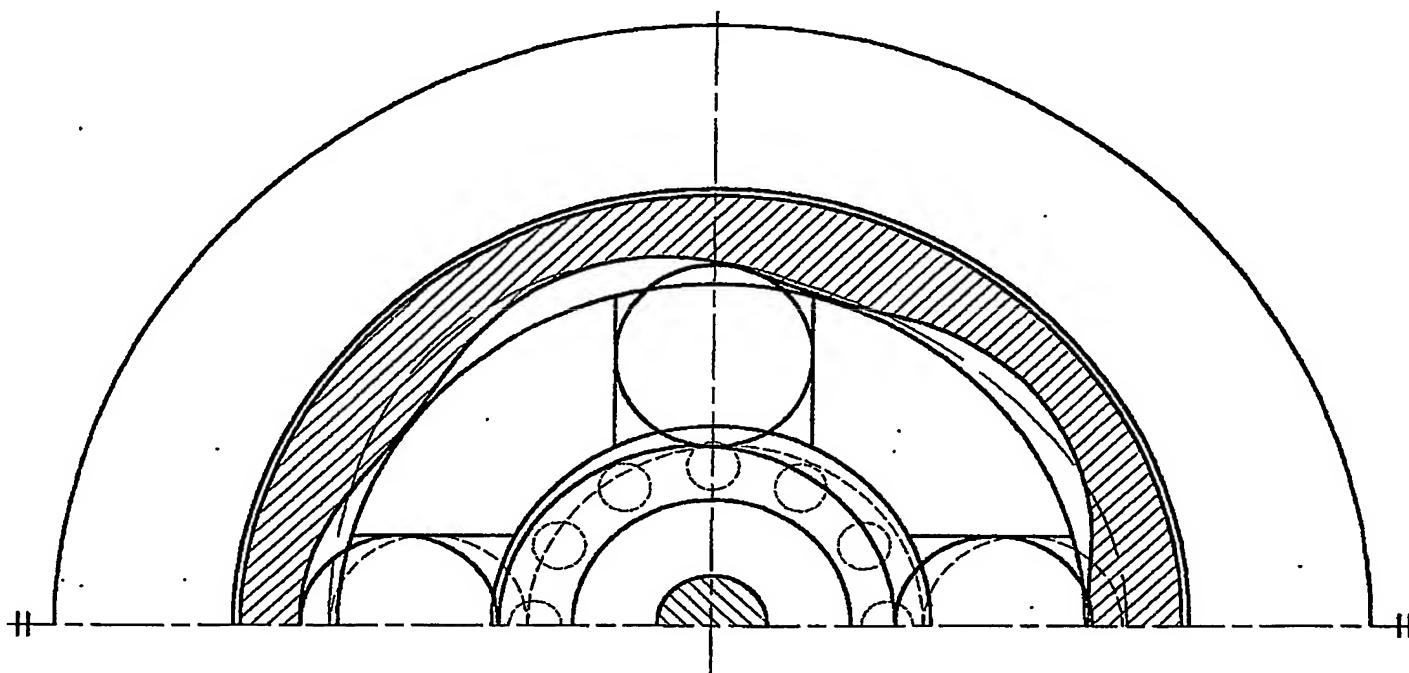


Fig 4.1
Shown as a cycloidal type
transmission (Rollers & Scallops).
Not to scale.

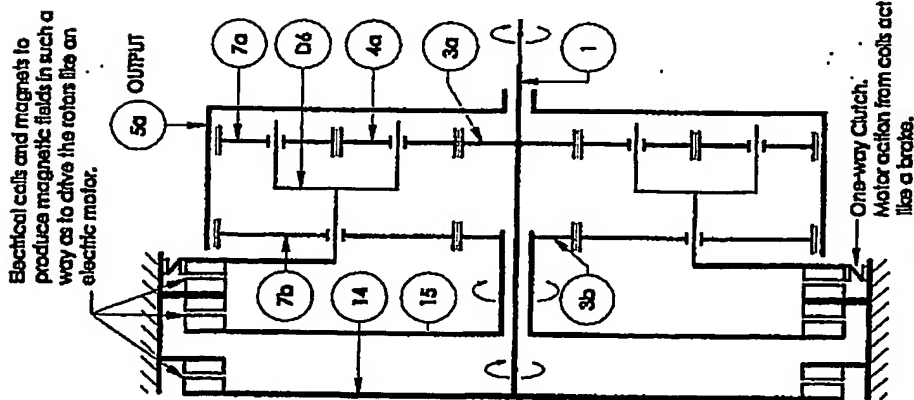


Fig 4.2(a)

This diagram shows a schematic layout of the transmission shown in Fig 4.1. Note that the directions of rotation of the rotors are shown rotating in the same direction, which means that the transmission ratio will vary between a minimum fixed ratio and 1:1. If the rotors are rotated in opposite directions (contra-rotating), the transmission ratio will be the fixed ratio.

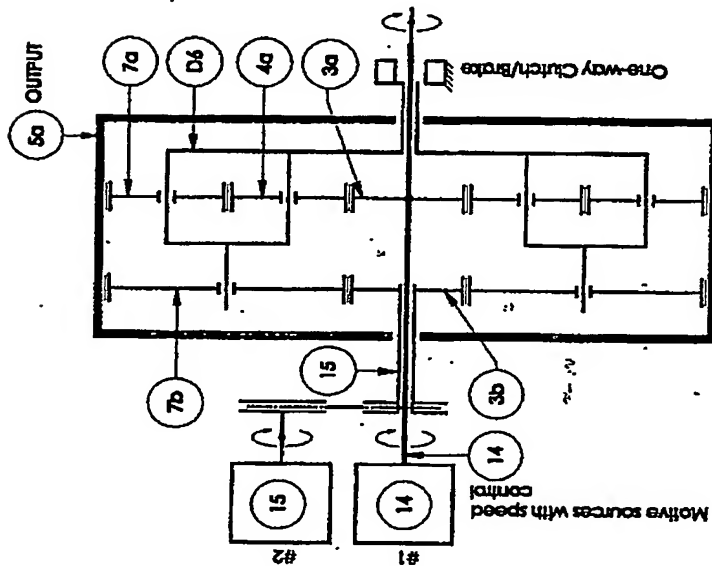


Fig 4.2(b)

This diagram shows a schematic layout of an equivalent transmission to that shown in 4.2(a). This arrangement replaces the rotors (14) and (15) with speed controlled motive sources. It also brings the (D6) Cage with One-way Clutch/Brake down through the body at the shaft. The note about contra-rotating inputs, as given for 4.2(a), also relates to this arrangement.

Fig 4.2

Shown as an epicyclic type transmissions equivalent to the cycloidal type transmission in 4.1. Not to scale. Input direction of rotations shown as an example only to show the three arrangements function in the same way. The rotation directions may vary.

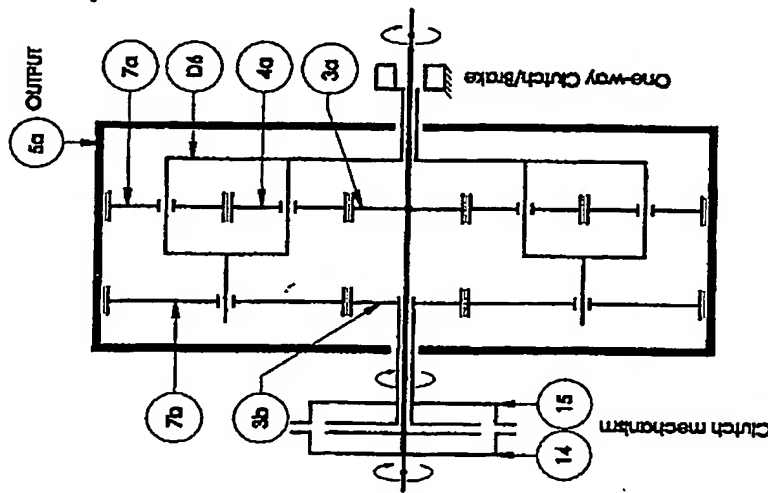
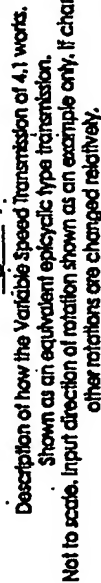
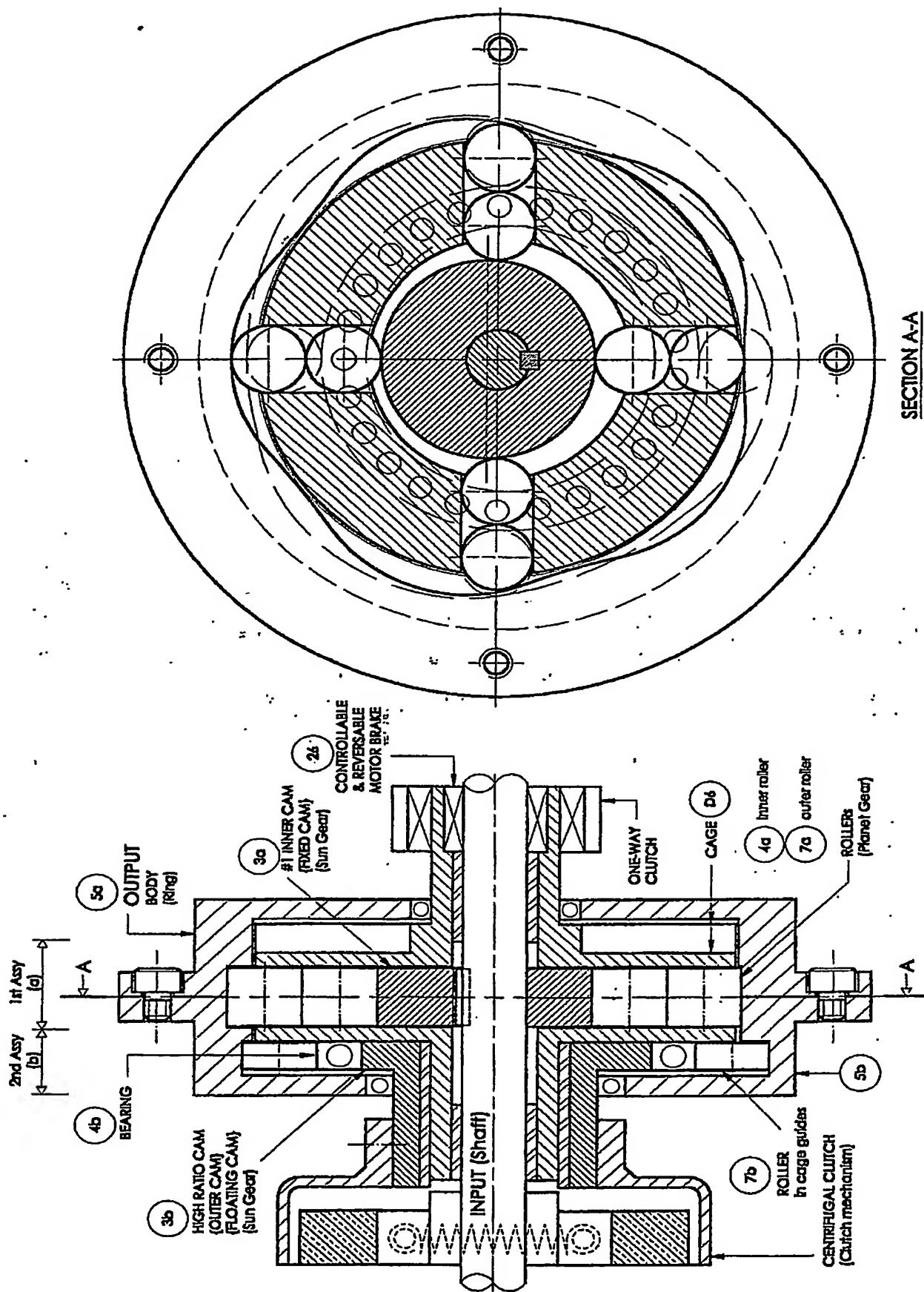


Fig 4.2(c)

This diagram shows a schematic layout of a transmission that controls the rotation of (14) and (15) by connecting (14) and (15) through a Clutch Mechanism. The amount of engagement of the Clutch determines the amount of rotation of (15) relative to (14). In Figs 4.2(a) & (b) the amount of rotation of (14) and (15) are determined independently by the speed control mechanism. The Clutch Mechanism can be automatically controlled and linked to the INPUT speed (for example a centrifugal clutch). With a clutch mechanism, the rotation of (14) and (15) will always be in the same direction, and therefore this arrangement does not have the capability of contra-rotating inputs as does 4.2(a) and 4.2(b).

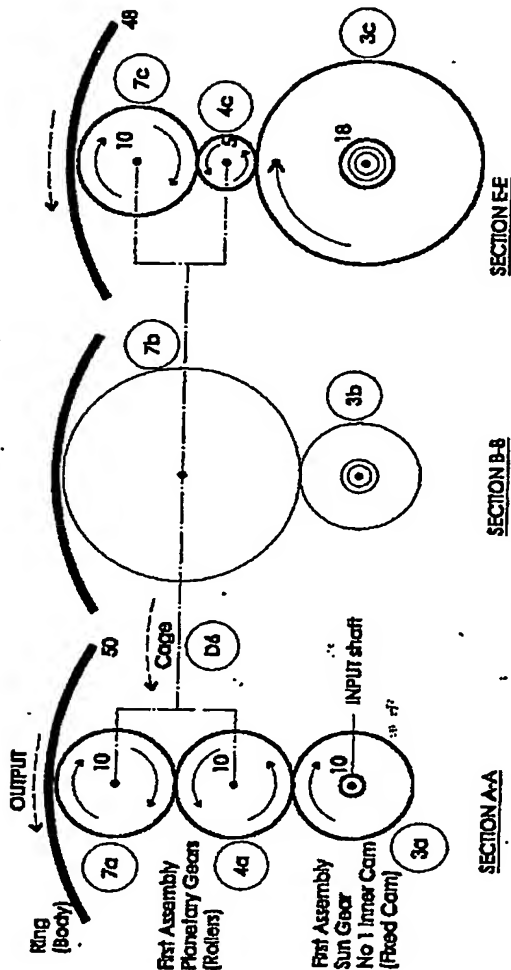
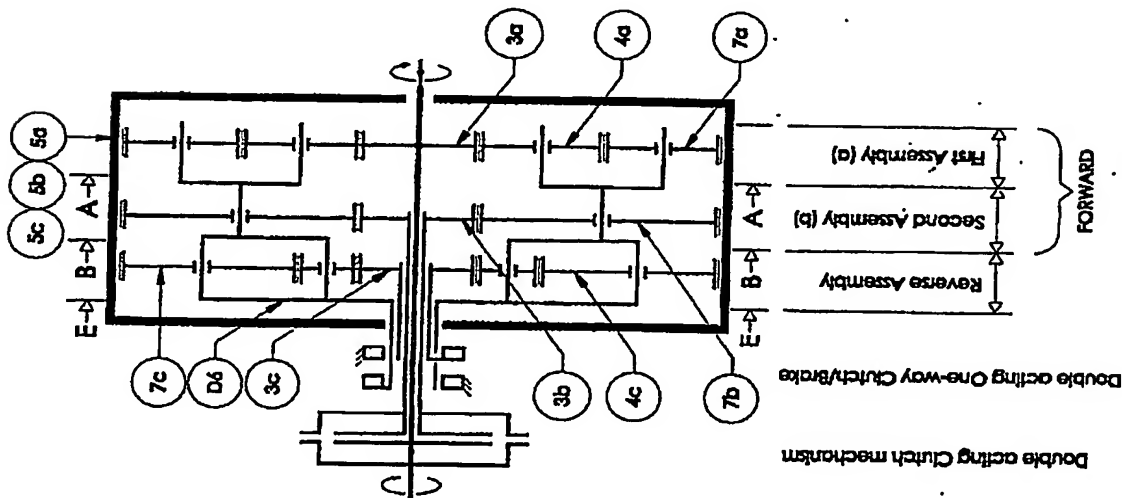




SECTION A-A

Fig 4.4

A cycloidal equivalent (Rollers & Scoops) to the transmission shown in 4.2(c).
 Not to scale.



To understand the interactions using the principle of superposition and an example using the numbers within the gears on the diagrams above as the number of gear teeth (or Pitch Circle Diameter etc.):

Assume 3(c) Sun-Gear is not fixed to the ground and the whole assembly is rotated as a whole, one rotation anticlockwise.

Hold the (D6) Cage.

Rotate the (3c) Sun-Gear clockwise back to its fixed position.

The total motion is found by subtracting 1 (the initial anticlockwise rotation) from these calculated values. The rotations of the planet gears (4c, 7c, 7a and 4a) about their own axis are the values of rotation before subtracting 1. The values of rotation with planet gears about their axis are as follows:

(3c) = 0 (i.e. fixed), (4c) = -18/5, (7c) = +18/10, (5a,b,c) OUTPUT = -30/48, (7c) = +900/480, (4c) = -900/480, (3c) = +420/480, (D6) = -1.

The number of revolutions or part revolution of the OUTPUT divided by the number of revolutions or part revolution of the (3c) Sun-Gear gives the OUTPUT ratio with respect to the INPUT i.e. $30/48 / 420/480 = 0.71$ with the OUTPUT rotating in the reverse direction.

Fig 4.5

A variation of the transmission shown in 4.2(c) with the capability of reversing the OUTPUT. Shown as an epicyclic type transmission. This transmission is based on the one shown in 4.2(c) with one extra assembly. It provides the capability of driving the OUTPUT in the reverse direction.

The forward direction is obtained by placing the Clutch Mechanism and One-Way Clutch in the forward mode. The arrangement that causes the OUTPUT to rotate in the forward direction is described in Fig 4.3

The arrangement that causes the OUTPUT to rotate in the reverse direction is described above.

Not to scale. Input direction of rotation shown as an example only. If changed all other rotations are changed relatively.

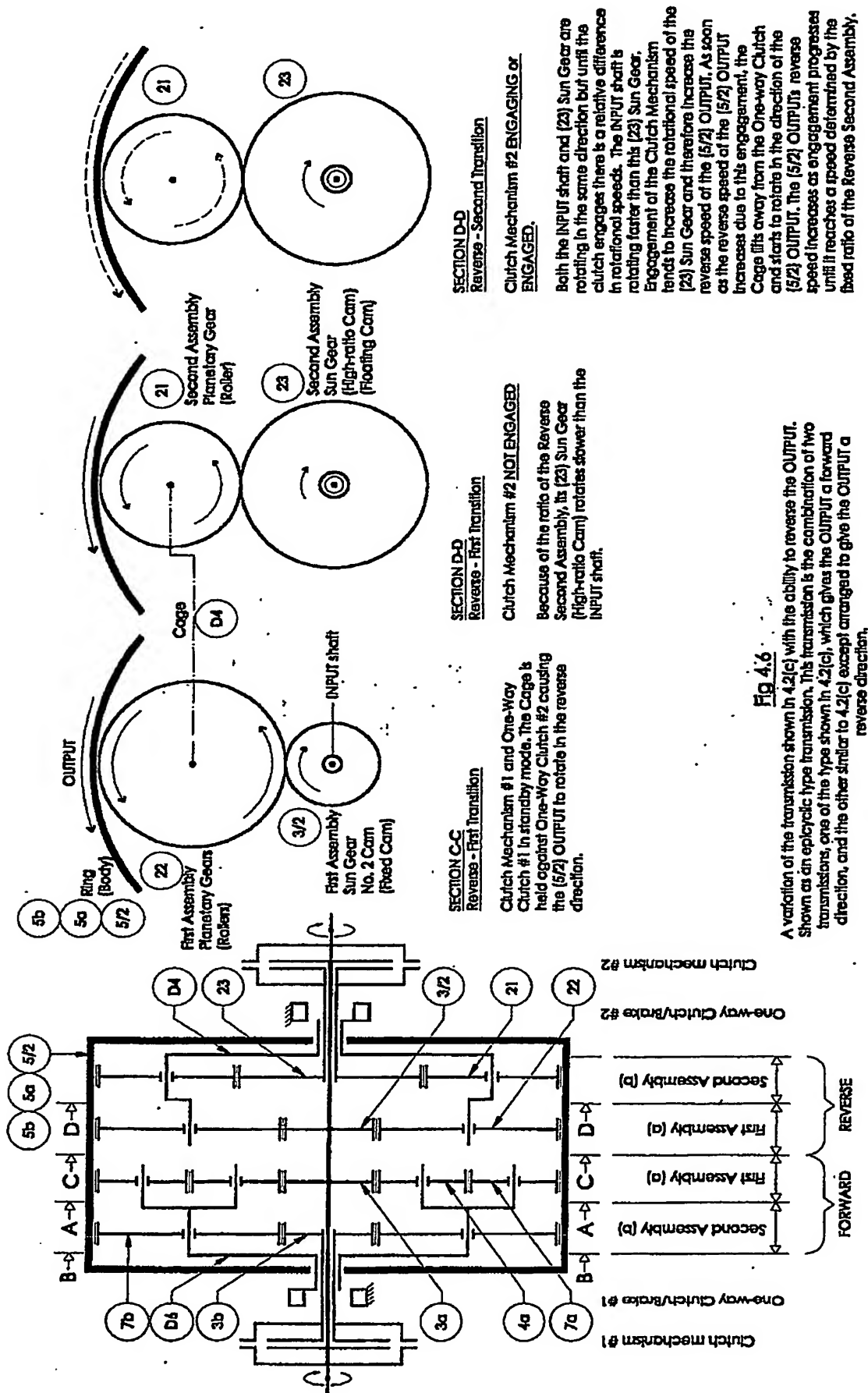


Fig 4.6

A variation of the transmission shown in 4.2(c) with the ability to reverse the OUTPUT. Shown as an epicyclic type transmission. This transmission is the combination of two transmissions, one of the type shown in 4.2(c), which gives the OUTPUT a forward direction, and the other similar to 4.2(c) except arranged to give the OUTPUT a reverse direction.

The forward direction is obtained by placing the Clutch Mechanism #2 and One-Way Clutch #2 in standby mode. The arrangement that causes the OUTPUT to rotate in the forward direction is described in Fig 4.3.

The arrangement that causes the OUTPUT to rotate in the reverse direction is described above.

Not to scale. Input direction of rotation shown as an example only. If changed all other rotations are changed relatively.

SECTION D-D Reverse - Second Transition

Clutch Mechanism #2 ENGAGING or ENGAGED.

Both the INPUT shaft and (23) Sun Gear are rotating in the same direction but until the clutch engages there is a relative difference in rotational speeds. The INPUT shaft is rotating faster than this (23) Sun Gear. Engagement of the Clutch Mechanism tends to increase the rotational speed of the (23) Sun Gear and therefore increase the reverse speed of the (5/2) OUTPUT. As soon as the reverse speed of the (5/2) OUTPUT increases due to this engagement, the Cage lifts away from the One-way Clutch and starts to rotate in the direction of the (5/2) OUTPUT. The (5/2) OUTPUTs reverse speed increases as engagement progresses until it reaches a speed determined by the fixed ratio of the Reverse Second Assembly.

SECTION D-D Reverse - First Transition

Clutch Mechanism #2 NOT ENGAGED

Because of the ratio of the Reverse Second Assembly, its (23) Sun Gear (High-ratio Cam) rotates slower than the INPUT shaft.

SECTION C-C Reverse - First Transition

Clutch Mechanism #1 and One-Way Clutch #1 in standby mode. The Cage is held against One-Way Clutch #2 causing the (5/2) OUTPUT to rotate in the reverse direction.

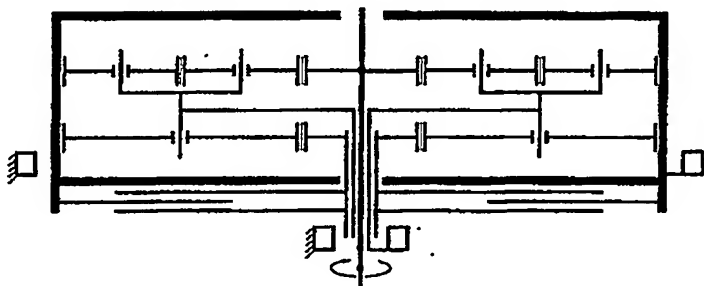
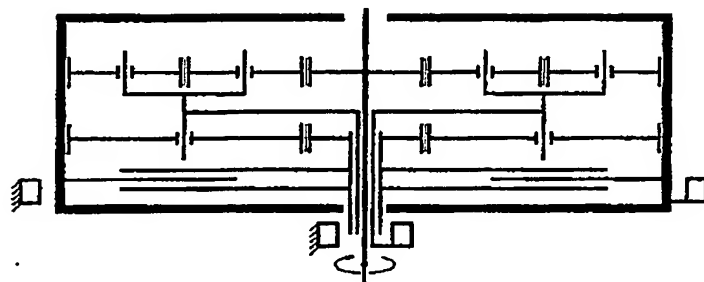
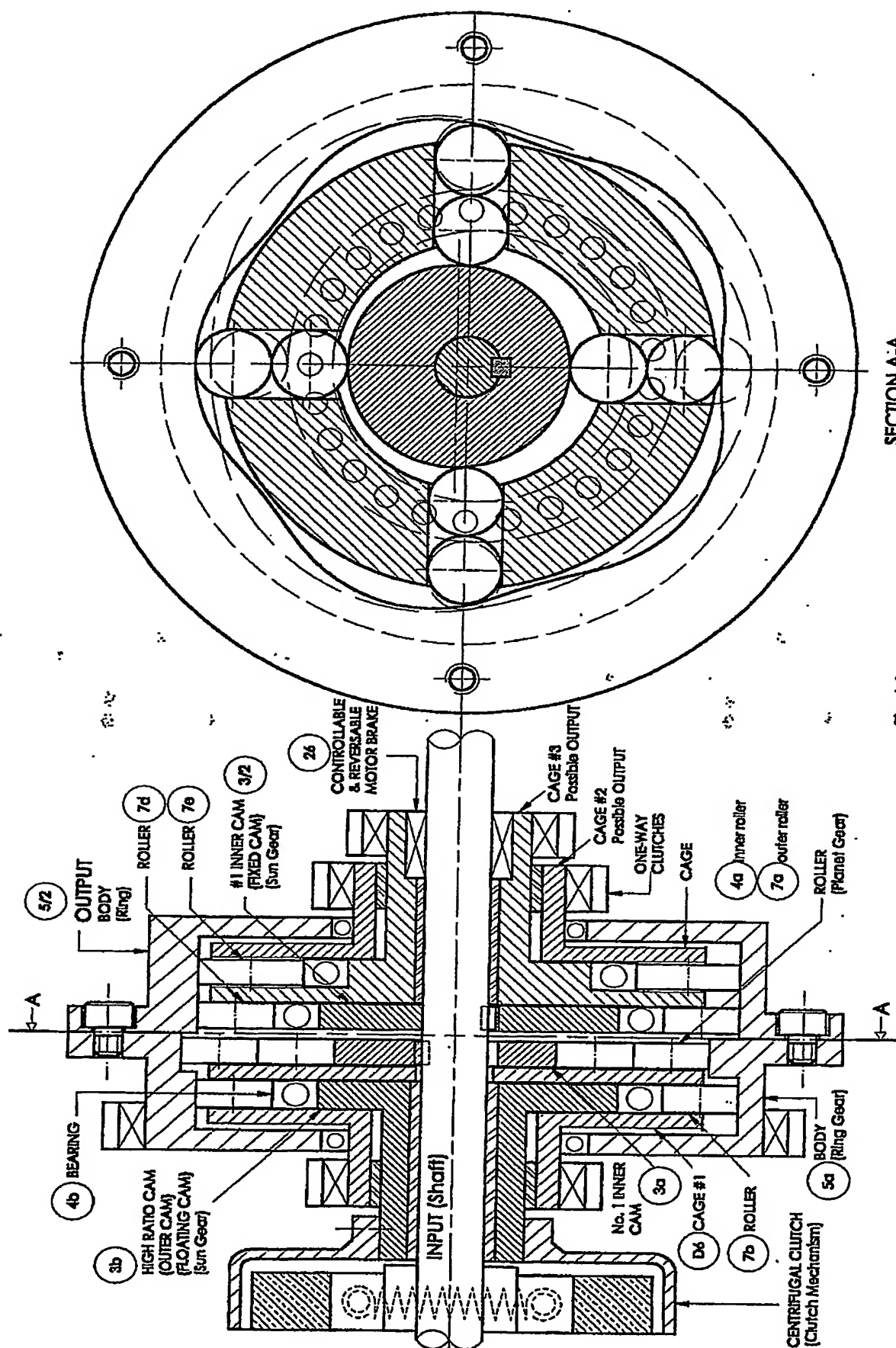


Fig 4.7

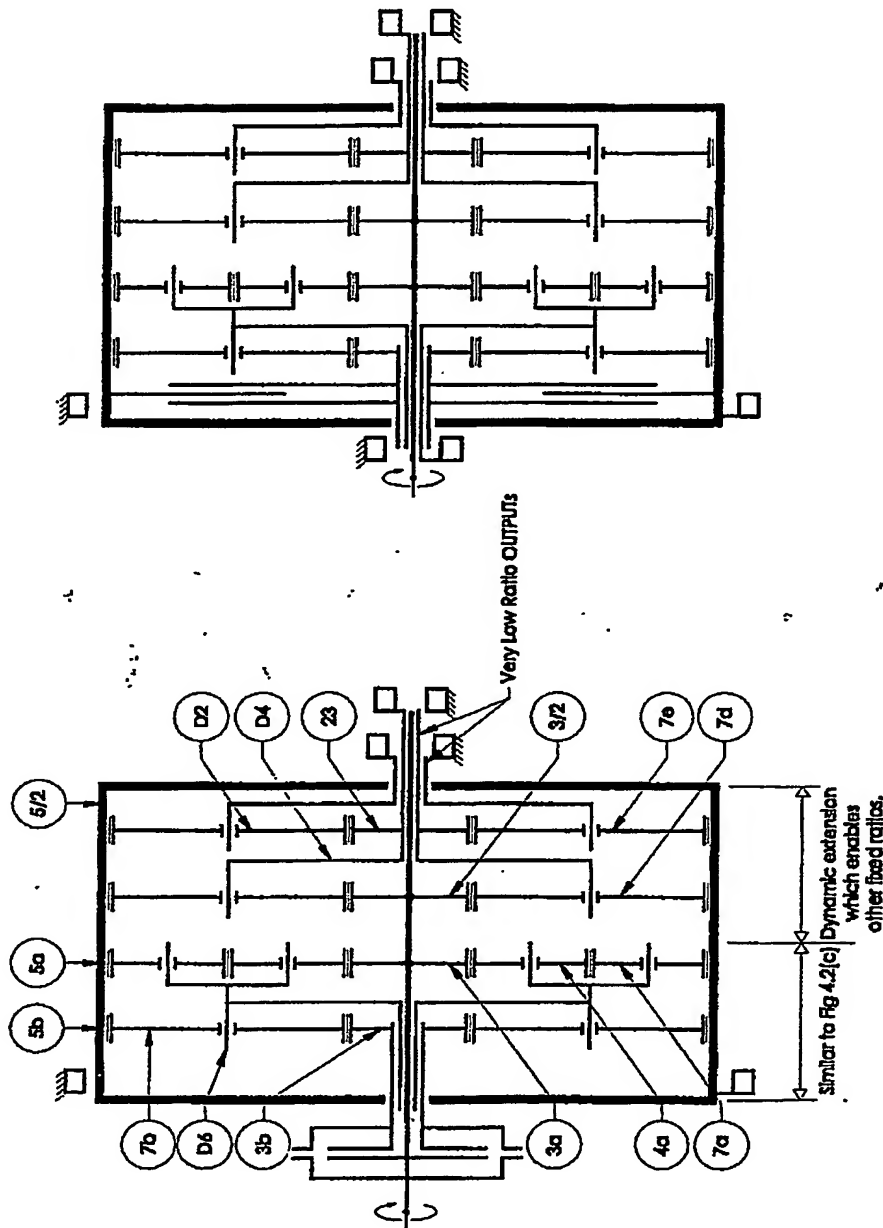
Variations of the transmission shown in 4.1.



SECTION A-A

Fig 6.1

Universal Transmission Shown with the various arrangements shown on the one diagram. Shown as a cycloidal type transmission (Rollers & Scallops). Not to scale.



The Body, (D2) and (D4) are the possible OUTPUTS depending on which One-way clutch is selected. The One-way clutch selected also determines the minimum ratio and the lowest speed from the OUTPUT. The OUTPUT speed can vary up from this selected ratio to the speed of the INPUT (1:1). Each One-way clutch can be manually selected as well as sequentially operated automatically.

The Clutch Mechanism can be external or internal with automatic or manual control. The Internal clutch mechanism can for example be a liquid polymer type of operation. Hydraulic pumping between Rollers & Scoops (in the cycloidal type transmission) acting like a pump in one assembly and a motor in the other can replace the clutch mechanism with the added benefit of providing lubrication under pressure where there is metal to metal contact.

Fig 6.2

Universal Transmission Shown with the various arrangements shown on the one diagram. Shown as a cycloidal type transmission (Roller & Scoops).
Not to scale.

NO3 C 20-12-0
PH 38498240
PH 0415747848

FIG 12-

THESE SHOULD BE DOUBLE ROLLERS FOR REVERSE
& SMALLER CAM (CENTRE SHAFT)

THE ONE WAY CLUTCHES GIVE OPPORTUNITIES FOR UNLIMITED METHODS
FOR A VARIETY OF TRANSITIONS WITH 1 WAY CLUTCHES & COUPLINGS

NOTE 1 WAY CLUTCH CAN BE INSIDE BETWEEN
WITH

OR 1 WAY CLUTCH CAN BE TO BICYCLE AXLE
WHICH CAN GO RIGHT THROUGH

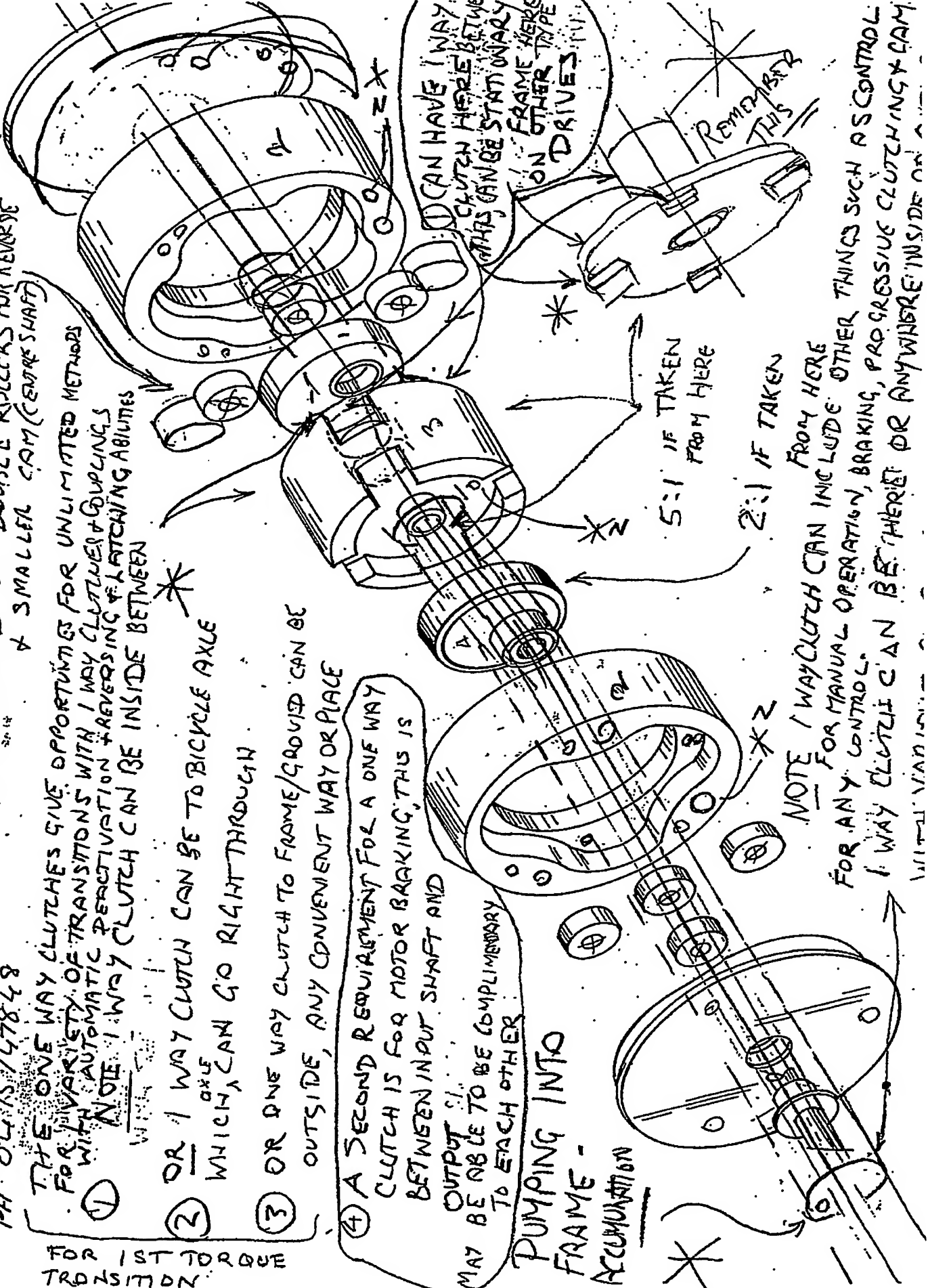
OR ONE WAY CLUTCH TO FRAME/GROUND CAN BE
OUTSIDE, ANY CONVENIENT WAY OR PLACE

A SECOND REQUIREMENT FOR A ONE WAY
CLUTCH IS FOR MOTOR BRAKING, THIS IS
BETWEEN INPUT SHAFT AND
OUTPUT

MAY BE ABLE TO BE COMPLEMENTARY
TO EACH OTHER

PUMPING INTO
FRAME -
ACCUMULATION

FOR 1ST TO 2ND
TRANSITION



NOTE 1 WAY CLUTCH CAN INCLUDE OTHER THINGS SUCH AS CONTROL
FOR MANUAL OPERATION, BRAKING, PROGRESSIVE CLUTCHING & CAM
1 WAY CLUTCH CAN BE THERE OR ANYWHERE INSIDE OR

Fig 3

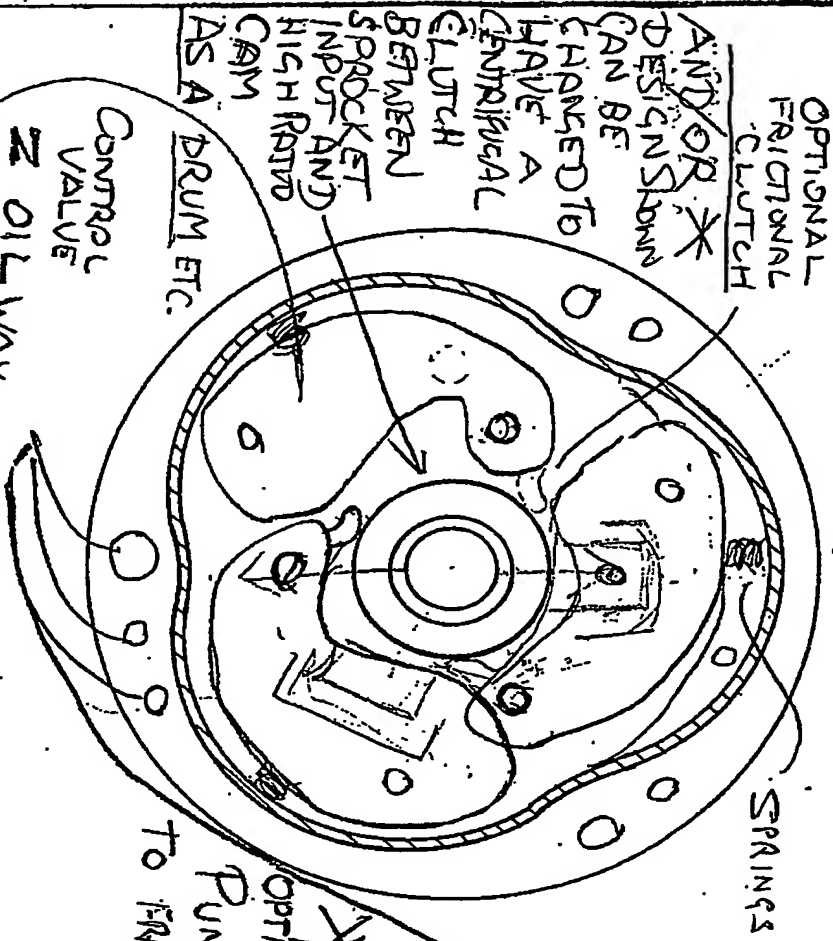
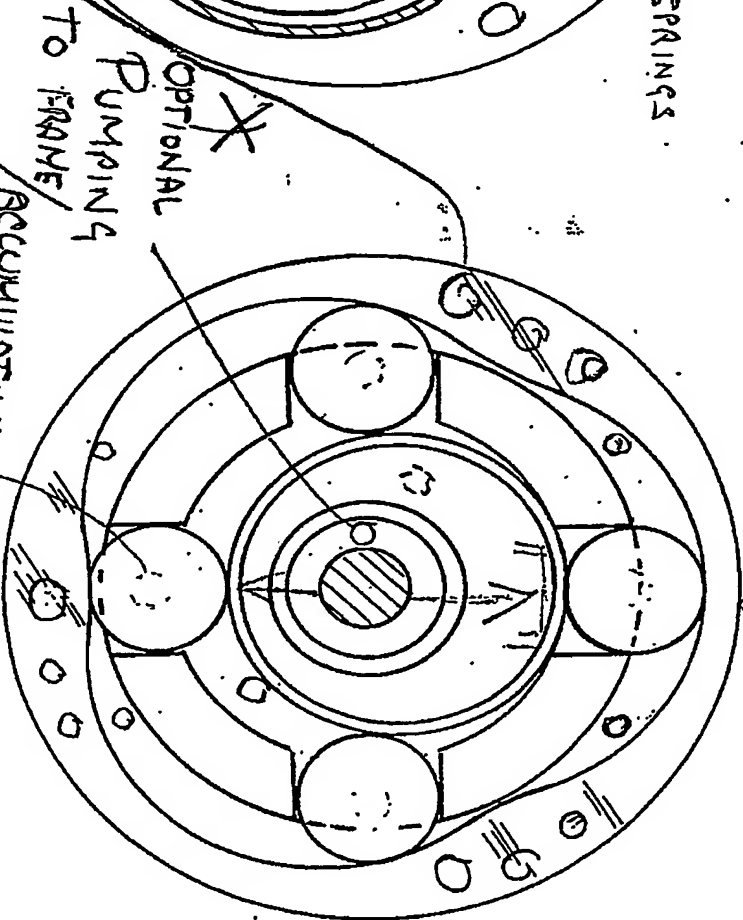


Fig 4



* INTERMITTENT EXTERNAL REGULATION THROUGH IE ENHANCED AXLE-STATIONARY

Fig 5

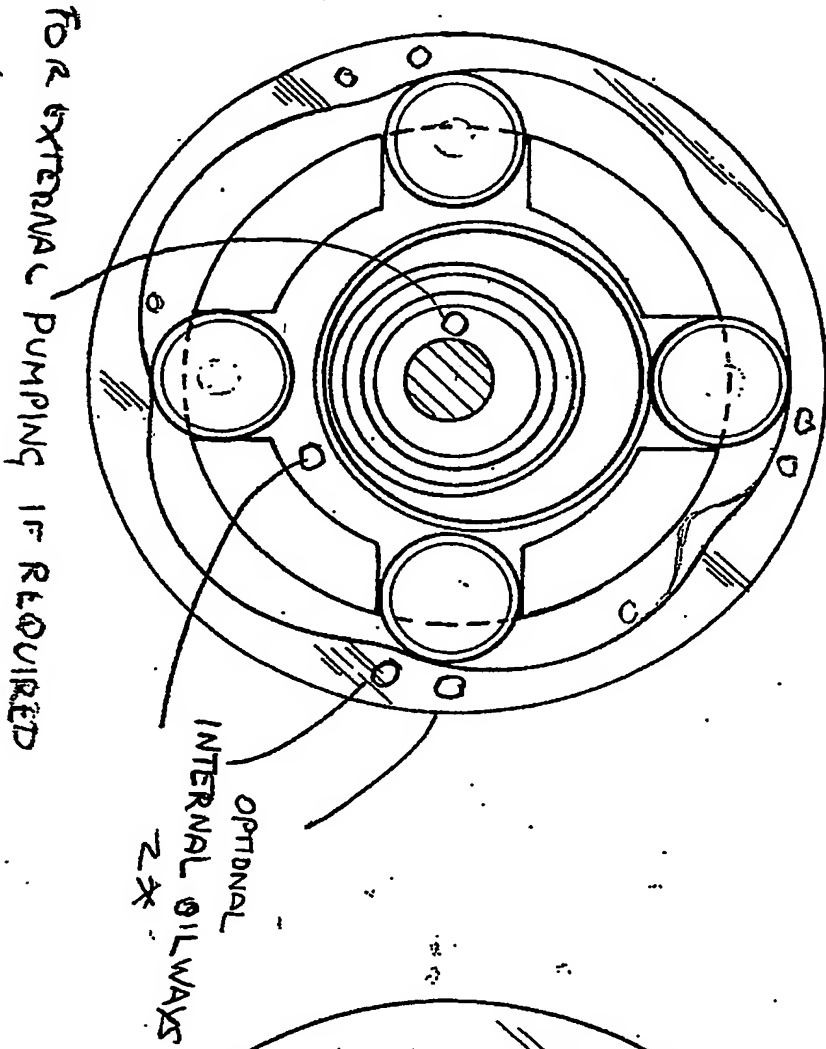


Fig 6

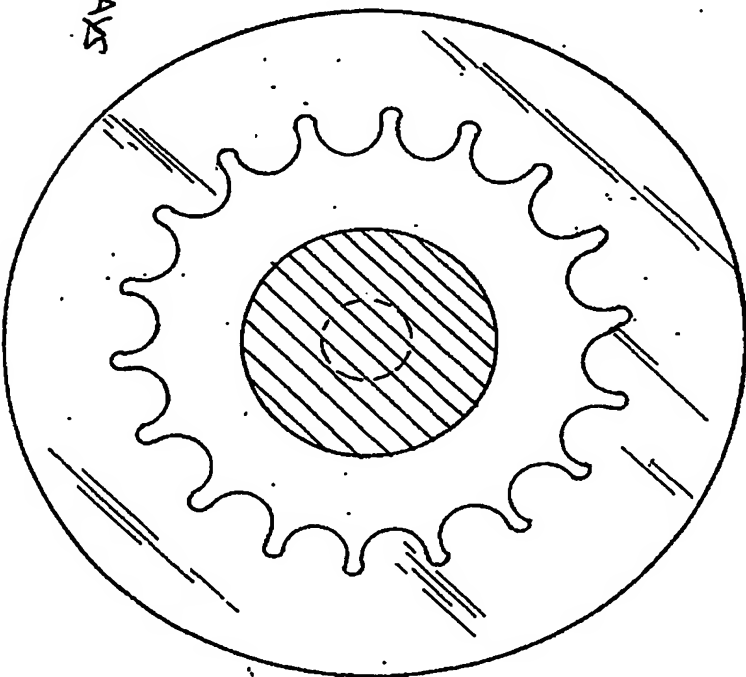


FIG 2 M REF FIG 1 M

SOME ALTERNATIVE CONTROLS. SEE BELOW FOR ONE OR MORE SEQUENTIALLY ACTUTED BRAKES AND CLUTCHING.

CAN HAVE MANY DIFFERENT CLUTCHING METHODS FOR A VARIETY OF APPLICATIONS, SINGLE OR COMBINED BRAKE AND CLUTCHING WITH OPTIONAL MOTOR BRAKE.

The two main transitions can be totally automatic clutching for speed control and regulation can operate with centrifugal action due to the rotation speed of the body having fixed ratios with the load/s and power source/s. Manual over ride controlling abilities can be combined. Alternatively sophisticated low cost micro-controllers can be controlling in simple methods with just one or two sensors or multiple sensors can integrate dynamic extensions with dynamic and static references. Clutching such as by magnetic particles and liquid polymers in oil types of coupling or hydraulic combinations are very complimentary. These can be totally internal or external combinations, by magnetic fields and any other method such as radiated electrical charges. These can alternatively be combined internally and externally, the elements of the transmission such as the cams/sun-gears can exchange positions to suit, internally or from either end.

The transitions can have any type of sequential stepping of ratios, operation with the combined ability to provide braking and reversing.

Gravitational sensors accelerometers tilt sensors can be combined with low cost yet sophisticated micro-controllers.

EXAMPLE - 1ST TRANSITION

Forward and reverse mechanism with engine braking capabilities

- B1 = Brake #1 to allow forward operation in first transition
- B2 = Brake #2 to allow reverse operation in first transition
- C1 = one-way clutch #1 to allow second transition in forward operation
- C2 = one-way clutch #2 to allow second transition in reverse operation
- C3 = one-way clutch #3 for engine braking in forward operation
- C4 = one-way clutch #4 for engine braking in reverse operation
- 3a = input shaft
- D6 = carrier cage

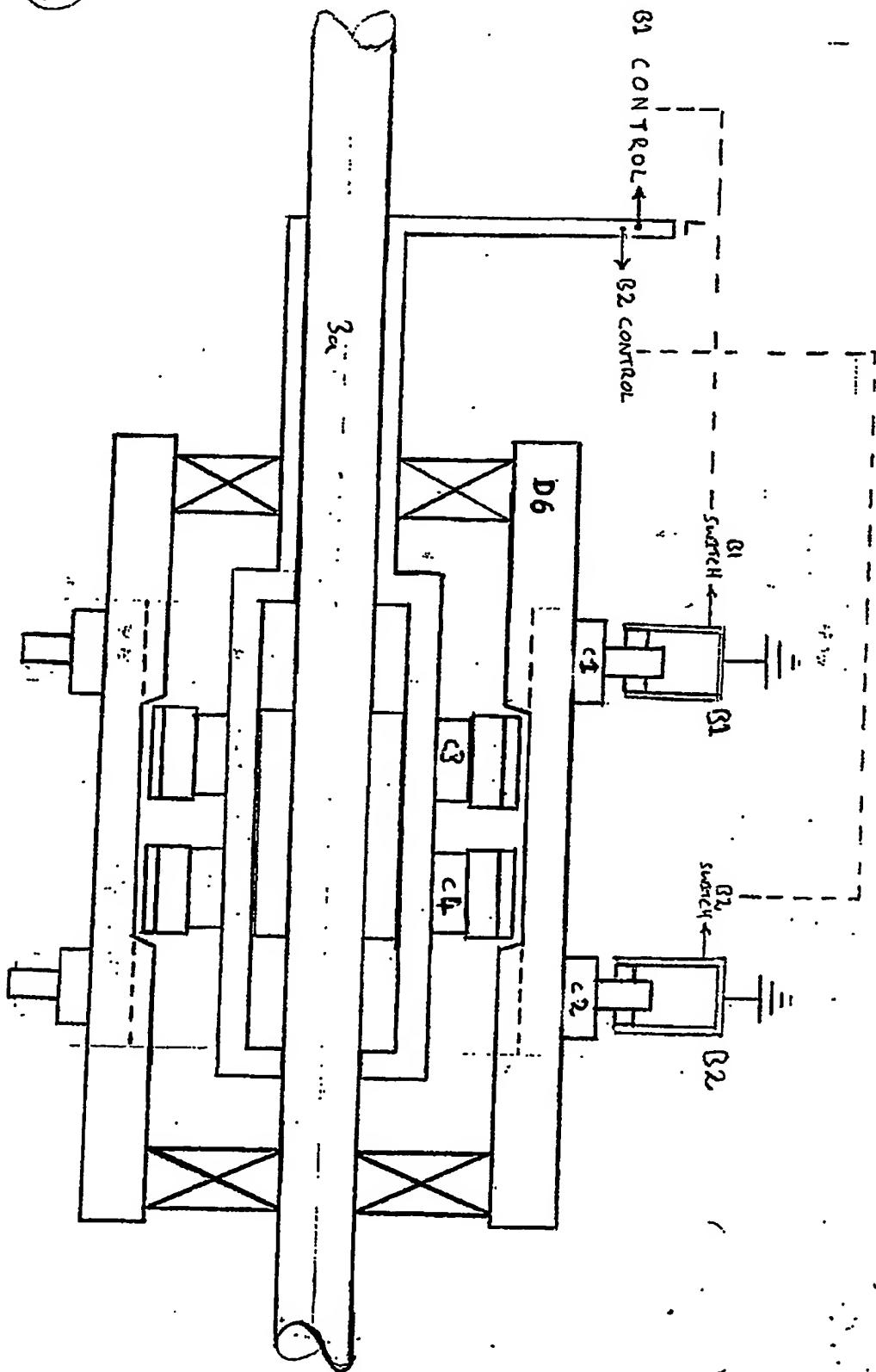
Forward

B1 and C3 are both engaged to D6 when forward rotation is required from the body. B1 works in tandem with C1 to ensure that D6 cannot rotate backward with respect to 3a during the first transition. However since C1 is a one-way clutch D6 can rotate forward with respect to 3a. C3 is also a one-way clutch and ensures that D6 cannot rotate forward with greater angular velocity than 3a, i.e., D6 can drive 3a during both the first and second transitions and thereby provide engine braking in both transitions.

Reverse

When reverse rotation is required of the body, B2 and C4 are engaged to D6. B2 works in tandem with C2 to ensure that D6 cannot rotate forward with respect to 3a during the first transition

(M)



Top (normaly)

Fig 1 M

(10)

TITLE VARIABLE RATIO MULTI-GEAR

(continued from page 1B, as previously described).

This invention relates to devices for the transmission of mechanical power in the form of rotational motion. In particular, it is directed to transmission of power between a first rotationally movable element and a second rotationally movable element to provide a device which can provide, in a preferred form, continuously variable ratios, of angular velocity at an input to angular velocity at an output, within the range of ratios -1:1 to 0 to +1:1.

- 5
- 10 The present invention finds use in electronic, hydraulic or mechanical applications and, in a preferred form, provides variable input and output speeds; an output angular velocity that varies from 0 to \pm the gear ratio as the input varies from zero to the input angular velocity; torque multiplication; the ability to vary speed and torque. Furthermore, the present invention provides multiple
- 15 inputs and/or outputs and reduction, step up or 1:1 gear ratios. This invention includes the use of a planetary drive, that is a drive which includes a set of rollers, bearings or similar moveable parts, arranged in a circle around an axis and configured so that, through their movement in concert, apply torque to a body whose resultant rotation is used as the output of the drive. Examples of
- 20 similar drives are described in Australian Patents 607822 and 613927 as spin control differentials for vehicles and couplings. A planetary drive based on a sun gear, a ring gear, and a planetary gear carrier is disclosed in Australian Patent number 465202 in the name of Eaton Corporation.
- 25 Examples of planetary drives are manufactured by Sumitomo Heavy Industries Ltd, Japan, under the name "cyclodrive".

Although planetary gears are known, the prior art gears have failed to take advantage of certain of their features, in particular, the contra-rotational nature of

30 the input and output shafts being on the same axis.

It is a general object of one or more various preferred embodiments of the present invention to provide a device which can provide a continuously variable output angular velocity to input angular velocity ratio; to provide a device which can combine more than one input angular velocity ratio to provide a device
5 which can provide one or more angular velocity output; to achieve this, sophisticated techniques involving integrating, balancing or heterodyning more than one rotational force, by either mechanical or electrical means. The invention is capable of absorbing energy from or inputting energy to the output, thus providing regenerative braking or acceleration according to the power
10 output demand. The effect of electronically controlling the self-braking of the contra-rotating magnetic discs produces the mechanical equivalent of the input forces causing a constantly variable output in speed with variable torque.

In a first embodiment, the invention resides in a variable ratio gear including:
15 a planetary gear and a variable brake;
said planetary gear including an outer body, at least one cage and a center shaft;
a first means between said center shaft and said cage;
a second means between said cage and said outer body;
20 wherein, upon rotation of said shaft, at least one of said outer body and said cage is caused to rotate;
and wherein said variable brake includes a variable load means supported between said shaft and said cage such that variation of a load between zero and a maximum value corresponds to variation of the ratio of the angular
25 velocity of said outer body to the angular velocity of said shaft.

In a second embodiment, a planetary gear has a variable balancing mechanism between any of the main three components of the gear which will allow for combining one or more rotational angular velocity, with or without the use of
30 a variable brake so that rotation of any said component will likewise cause

rotation in at least one of the other components, providing one or more angular velocity output also with the choice of contra-rotation.

5 Preferably, the cage includes a plurality of fingers joined at one end to a common plate and there are a plurality of rollers located between the fingers. The outer body of the planetary gear preferably has a plurality of scallops on an inner surface adapted to receive the rollers. The drive shaft preferably includes an offset cam in sequential operable connection with the rollers such that rotation of the drive shaft causes the cam to sequentially rotate the rollers
10 thereby rotating the outer body. The number of rollers differs from the number of scallops.

The variable brake may suitably be a magnetic load applied between the drive shaft and the cage. The maximum load applicable by the brake is preferably
15 sufficient to lock rotation of the cage to rotation of the drive shaft.

Preferably, the variable brake is continuously and smoothly variable between zero load and maximum load. The load provided by the variable controller or brake may suitably be controllable by a feedback signal derived from a
20 measurement of the angular velocity of the body, cage and shaft.

In another embodiment, the variable brake comprises two separate drives, one drive for the shaft and one for the cage, such that heterodyning of the drives produces an output angular velocity of the outer body. The separate drives can
25 be applied to any two components of the variable ratio gear and the resultant output angular velocity will appear at the other components. Any source of initial power input can be used, eg, magnetic, hydraulic, manual, wind power.

In yet another embodiment of the invention, a fixed speed reduction or
30 acceleration can be combined for such requirements as contra-rotation of two

(or more) turbines at either ends or opposite ends of a motor. Any type of feedback may allow the control of load sensing to equalise, using for example, fluid pressure.

In order to assist in further understanding the invention a number of preferred embodiments will be described with reference to the attached figures in which:

FIG 1: illustrates the end-on view of an example of a planetary drive.

FIG 2: illustrates a side-on cross section view of one embodiment of the present invention.

FIG 3: illustrates a first embodiment of the present invention.

FIG 4: illustrates a second embodiment of the present invention, namely, two self-contained electric motors with integrated gear, having available electronic, or electro-mechanical biasing, ramping, or a type of "yo-yo" effect allowing the motors to operate at their optimum torque and speeds.

FIG 5 - 11: illustrates other various embodiments and uses of the present invention.

FIG 11-31: illustrate other equally important embodiments and uses of the present invention.

In order to describe the present invention, it is first necessary to describe the operation of a planetary drive. FIG 1 shows a view, along the drive axis, of a planetary drive. Clamped to an input drive shaft (1) is a cam (3), clamping sufficient so that the cam does not slip on the shaft (1). Surrounding the cam is a circular arrangement of 8 rigid objects, referred to here as "rollers" which can move radially as allowed or forced by the cam. Maintaining constant angular separation of the rollers is an arrangement of 8 "fingers" which are all joined at one end and remain fixed relative to one another through connection at one end to a common body (6). The combination of the fingers and the common body (6) is referred to as the "cage". Surrounding the cage is the "outer body" (5),

whose exterior is cylindrical but whose interior wall has indentations or "scallops" whose purpose is to receive the rollers as they are pushed out by the cam. In FIG 1, the number of scallops is 9. In order to achieve movement of the outer body through rotation of the shaft (1) and the cam (3), the number of scallops must be different from the number of rollers.

5. In other examples of planetary drives, the rollers are referred to as "peanuts" and may be rigid slides or multiple rollers or may have axles, but the principle of operation of the drive remains identical. It can be seen from FIG 1 that, if the cage is held fixed so that it cannot rotate about the drive axis, the outer body will rotate one complete revolution for every 9 complete revolutions completed by the drive shaft and that the direction of rotation of the outer body will be identical to that of the drive shaft. Furthermore, it can be seen that were the number of scallops equal to the number of rollers, the rollers would quickly align with the troughs of the scallops and the action of the cam forcing the rollers into the scallops would not apply any torque to the outer body.

It should also be noted that were the outer body to be prevented from rotating about the drive axis with the cage left free to move, the cage would then rotate about the drive axis in the opposite direction as the rotation of the drive shaft and cam, and that the cage would complete one such revolution for every eight revolutions of the drive shaft.

In a further embodiment where there are more rollers than scallops, if the cage is held fixed about the drive axis, the outer body will rotate in the opposite direction as the drive shaft with some multiplication of the rotation which is defined by the numbers of rollers and scallops. Also, if the outer body is held fixed about the drive axis and the cage left free to move, the cage will rotate in the same direction as to the rotation of the drive axis, again with some multiplication of the motion which is defined by the numbers of rollers and scallops.

It can also be seen that if one or the other of the cage or the outer body is held fixed with respect to the drive shaft, that is, if one or the other is compelled to have the same angular velocity as the drive shaft, then the third body is also compelled to have the same angular velocity as the drive shaft. For example, when a clutch
5 mechanism is installed in the planetary drive to keep the cage clamped fixedly to the drive shaft and the drive shaft is turned with some angular velocity, the outer body would also turn with an identical angular velocity.

For the sake of further explanation of this invention, consider the rotation of the
10 outer body to be the output of the system. Also, consider that the planetary drive is one in which the number of peanuts or rollers is smaller than the number of scallops in the outer body. In such a system, the drive will transmit some mechanical power, supplied at the input to the system via the drive shaft, to some mechanism attached either directly or indirectly to the output. The mechanism so
15 attached to the output will load the drive, and will be called the load. If such a load is large enough that it overcomes frictional torques within the drive and the drive shaft is rotated, the output will remain stationary and the cage will rotate in the direction opposite to that of the drive shaft if allowed to do so. If, on the other hand, the cage is forced to rotate with the same angular velocity as the drive shaft, the
20 output will also rotate with the same angular velocity. Supplying mechanical power to a load which is initially at rest can place unwanted strain on the devices providing the mechanical power to the input of the drive.

So far, two extremes of the situation have been considered. There is a continuum of
25 intermediate conditions which can be instituted by applying torque to the cage which opposes that torque which makes it spin in the direction opposite to that of the direction of the spin of the drive shaft.

Consider again the situation in which a substantial load is attached to the output
30 and the cage is left free to spin. If the drive shaft is rotated, the output will remain still and the cage will rotate in a direction opposite to that of the shaft. If, now, a

small opposing torque is applied to the cage which causes some reduction of its angular velocity while the angular velocity of the drive shaft remains substantially constant, the output will begin to move in the same direction as the drive shaft. The angular velocity of the output, with constant angular velocity of the drive shaft, is determined by gearing within the planetary drive and the amount by which the backward rotation of the cage is retarded. The magnitude of the retarding torque is a continuum, so the apparent gearing ratio, that is the input angular velocity compared to the output velocity, also appears as a continuum.

10

If enough retarding torque is applied that the cage stops spinning, the gearing ratio would be that which is directly calculable through counting the number of scallops and cam peaks, the number of peanuts or rollers does not generally enter into this calculation. If even more "retarding" torque is applied to the cage so that it begins to rotate in the same direction as the drive shaft the angular velocity of the output increases still more. If the retarding torque is increased so that the cage and the drive shaft have the same angular velocity the angular velocity of the output will be the same as that of the drive shaft.

20 It is also possible to apply enough positive torque so that the cage over-runs the drive shaft, that is, the cage has angular velocity greater than that of the drive shaft. This will cause the output to rotate with an angular velocity which is greater than that of the drive shaft.

25 It is possible to obtain an accelerated output either by applying multiple inputs to any of the three components of this gear, (as described in the windmill operation, pages 11, 12 and harmonic heterodyning) or by applying an opposite torque to the cage relative to the outer body in order to accelerate the cam. By using the present invention, a continuously varying turning ratio of the output drive shaft compared to the input, can provide the range of ratios from -1:1 to 0 to +1:1.

30

In this embodiment of the invention, FIG 2, this control is effected by introducing a magnetic brake (10) which is used to couple the motion of the drive shaft to the cage, using some of the torque supplied by the drive shaft to be the retarding torque applied to the cage. The amount of coupling between the drive shaft and the cage can be varied by varying the current supplied to the electromagnets of the magnetic brake, the more current applied, the greater the magnetic fields generated by the electromagnets and the greater the eddy currents produced in the cage. The eddy currents in the cage produce their own magnetic field which couple with the magnetic fields of the electromagnets and in doing so couple torque to the cage which is in the same direction as the angular velocity of the drive shaft. This is the retarding torque.

Further to this embodiment, there is a variable "throttle" whose position indicates the desired final speed of the loading mechanism attached to the output. The position of the throttle is measured in such a way that its position is indicated by an electrical signal. There is also a speed detector which measures the instantaneous speed of the loading mechanism. The source of driving torque is a synchronous electric motor which has a current detector attached to its source of electrical power to provide a measurement of the instantaneous current being drawn by the synchronous motor. A synchronous electric motor is one which is best operated such that its output shaft turns at a constant speed, or angular velocity. This invention allows the use of such a motor even though the device has a continuous variable output angular velocity.

The measurements of the throttle position, the speed of the load and the current being supplied to the synchronous motor are fed as electrical signals to an electronic device which provides an output signal which controls the amount of electrical current supplied to the electromagnets of the magnetic brake. That is, the output signal controls the amount of coupling of the torque of the drive shaft

to the cage. This feedback system is set to keep the angular velocity of the synchronous motor close to its optimum value while the load accelerates to the desired final speed.

5 A description of a typical accelerating sequence will now be given. With the load at rest, the synchronous motor is turned on and allowed to attain its optimum angular velocity with no controlling current applied to the electromagnets of the magnetic brake and therefore with no coupling between the drive shaft and the cage. As the motor gains speed, the cage spins with
10 increasing angular velocity with a direction opposite to that of the drive shaft. Assume now that the throttle is moved to a position which indicates that the desired maximum speed of the load corresponds to that attained when the angular velocity of the output of the planetary drive is equal to that of the drive shaft.

15 The feedback mechanism produces a signal which causes a certain amount of electrical current to be supplied to the electromagnets of the magnetic brake which couples a retarding torque to the cage. As the angular speed of the cage falls, due to the retarding torque, the output begins to move causing the load to accelerate. The brake is thus acting like a slipping clutch at this point. The load
20 which is now placed on the synchronous motor causes its angular velocity to decrease, an effect which is measured by the current detector attached to the source of electrical power. If the loading of the motor is too great, the feedback circuit causes the current to the electromagnets to be decreased, lessening the coupling of the drive shaft and the cage, in turn reducing the loading on the output.

25 If, on the other hand, the motor is operating at an angular velocity which is somewhat greater than its minimum, the feedback circuitry provides a signal which increases the current supplied to the electromagnets, increasing the coupling between the drive shaft and the cage and increasing the angular velocity of the
30 output. In this manner, the load is accelerated whilst the synchronous motor is never over-loaded.

In this embodiment, the acceleration continues until the angular velocities of the drive shaft and the cage are as close as possible except for the inevitable slight "slipping" of the magnetic brake.

5 By connecting a further system to the output shaft, or by using the output shaft itself, it is expected to effect magnetic braking for speed control or governing, or for the return of energy to an electrical accumulator system during a cycle of magnetic braking.

10 It will be understood that any driving source such as combustion or other motors can similarly benefit using this system so that the optimum speed for the source can be used. It may therefore be required that other forms of load sensing such as load cells be employed to obtain the feedback needed to control the amount of magnetic coupling needed.

15 The effect of biasing the output of a mechanical system would be easily achieved using this planetary gear as outlined in this patent. One driving motor would provide the D.C. bias or constant component of the output drive while another could be attached to one of the other elements of the gear and add or
20 subtract from the angular velocity of the output. Indeed, the variable speed motor drive as outlined above is an example of such a biasing system if the magnetic brake is considered as a form of electric motor.

Heterodyning of the two varying input angular velocities to produce one varying
25 output angular velocity could be easily achieved by controlling both input velocities by means of separate motors. This could produce a cyclical "beating" effect in the output of the system, or a less cyclical output, depending upon the harmonic components of the inputs.

30 The planetary gear shown in FIG 1 and FIG 2 provides for one set of rollers (7) and one cam but there is the ability to equalise and balance the gear for smoother and

more powerful operation by the addition of one (or more) sets of cams (3) and rollers (7) which may also be used within the same outer body or bodies (5) and scallops (9). The increase in surface to surface contact thereby gained is expected to be an advantage in both high speed or low speed requirements. The
5 cams could be related to each other at any angle within 0 to 360° of each other to provide maximum efficiency.

Multiplication of the gear ratios can also be added to the previously mentioned ratios, with the addition of a second cage (6) and a second set of rollers (7). The
10 cage would be directly connected to the second cam (3) thus providing a multiplication of 1:64 ratio in the examples shown in FIG 1 and FIG 2 and can be designed to be used at the same time as any of the other ratios. The rollers (7) may be tapered as may also the outer body scallops (9) in order to allow for wear or reduce noise, spring loading could also be combined.

15 Another application is seen in a windmill which can be efficiently operated with a greater range of wind speeds than windmills with similar output powers. The windmill has two turbines for the conversion of wind energy into rotational mechanical energy, one of the turbines being joined fixedly to the drive shaft of
20 a planetary gear assembly and the other turbine being joined fixedly to either the outer body or the cage of the planetary gear assembly. The rotational axes of the turbines are co-linear with the rotational axes of the drive shaft, the cage and the outer body of the planetary gear. The turbine connected to the drive shaft would be of substantially lesser diameter than the other turbine. An output
25 shaft is connected to either the cage or the outer body of the planetary gear assembly, whichever is not joined to the larger turbine.

In one embodiment of this system, the turbines would have pitches of their respective blades arranged so that, with a wind driving both turbines, the turbines
30 would counter-rotate. The larger of the turbines is joined fixedly to the outer body of a planetary gear assembly which is of a type whose outer body will rotate in the

same direction as the input shaft and can rotate when its cage is held still with respect to the ground.

5 In a light wind and with a loaded output many windmills fail to turn because they cannot produce enough torque at their outputs to overcome the inertia and static friction within their loads and the bearings of their turbines. In the windmill embodiment of the present invention, the planetary drive is designed so that its drive shaft has a large mechanical advantage over its output when its outer body is held stationary with respect to the ground. In a light wind the smaller turbine will begin to rotate and the planetary gear will begin to apply torque to both the larger turbine and the output shaft. One or the other or both of the larger turbine and the output shaft will begin to rotate due to the torque thus applied. If the larger turbine rotates under the influence of this torque, it will rotate in the same direction as the smaller turbine, that is, in the opposite direction to which it would rotate under the influence of any torque produced by the action of the wind on its blades. This will produce a braking effect on the larger turbine, slowing its rotation and in turn applying more torque to the output shaft. In very light winds this braking effect will not be enough to completely halt the backward rotation of the larger turbine and the smaller turbine will therefore not be halted by the resistance of the load.

As the velocity of the wind increases, more torque is applied to the input shaft by the blades of the smaller turbine and more torque, in the opposite sense, is applied to the outer body by the blades of the larger turbine. At some wind velocity the torque on the larger turbine, produced by the action of the wind upon its oppositely pitched blades, will be enough to cause it to stop or even begin to turn in the opposite sense to the rotation of the smaller turbine. The varying angular velocity of the larger turbine changes the ratio of the output shaft to input shaft rotation from 0:1 when the output shaft does not move to $x:1$ as the output shaft begins to move, where x is a continuous variable which can actually exceed 1.0 if the larger turbine rotates quickly enough. Useful mechanical drive can be achieved with this

windmill over a large range of wind velocities as it can be designed such that the turbine to output mechanical ratio varies continuously as the velocity of the wind changes.

5 However, applying the well known advantage of simply contra-rotating two propeller blades using the cam output on this gear to provide an accelerated output could be used. The prior art describes examples of using such a gearbox and there are several basic principles involved, within the variable speed drive, however, a secondary principle can enhance this gear which is the ability to incorporate huge advantages through the
10 inclusion of a harmonic heterodyning of the relative drives. To attempt to achieve for example, standing waves, and a much higher efficiency, several different ways may be used, by choosing the best R.P.M. such as, for example, using a 6:1 ratio with the windmill gear ratio and combining a propeller design and size which will match. Another way would be to incorporate a second driving motor as well as the magnetic
15 brake previously described, then running it at the best speed to achieve as close to a standing wave effect of frequency as possible, likening it to have three motors.

In other embodiments, the magnetic brakes on the previously described magnetic drive to be designed to drive at some suitable speed which would be calculated to suit,
20 providing harmonic heterodyning or a biasing ability.

There are many different ways and applications that can incorporate this harmonic system in any of the applications.

25 Another application for this gear would be with the use of extremely versatile and accurate measuring systems where the multiple shaft turning can provide up to a three way measuring system providing three way torque curves - either manually operated, or computer controlled, stepping motors or simple reversing motors could provide extreme accuracy combined with fast operation. In one method, by choosing motor
30 operation, one motor could add and subtract acting like a biasing motor whilst the other could provide extreme accuracy.

Another every day application for this gear is expected to be an everlasting, super efficient clutch for vehicles for example by accelerating the centre shaft providing a more efficient clutching action.

- 5 The concept of using the planetary drive in such a way that all three of its major elements, that is the input shaft, the cage and the outer body, is a cheap and compact way of bifurcating the angular motion of a system. Conversely it can also be used to combine the angular motions of two separate systems into one output. The distribution of the torque in the bifurcating system can accurately be controlled
- 10 through the use of clutching or braking systems to restrict the motion of one output and, in doing so, produce a greater or lesser torque at the other output. The clutch or brake can be configured to return inertial energy to the input so that it may be produced at the output at some later time.
- 15 Another application is expected to be the use of this gear for infinitely variable speed drives for vehicles such that the third output provides a balancing regenerative power source which can add to the driving motor power. Any of the three outputs can be used so that the energy can be stored in either a flywheel or combined other useful power requirement such as generators or
- 20 superchargers or similar. When the vehicle is coming to a stop, the braking can propel this storing system automatically or manually, on acceleration, this stored energy is added to the main driving power. While stationary, the main motor may propel the stored energy system through the planetary drive because the brakes are on.
- 25 A simple coiled spring could be used in applications where only a short torque advantage is needed to, for example, give a load a kick-off.

Using the feedback or biasing ability, a lighter load may be lifted faster automatically and can be designed into a robotic ability to perform useful reactive actions as well as to bend the elbow of an arm as the load increases.

- 5 By design choices of gear ratios, input and output R.P.M heterodyning could significantly increase the efficiency of not only the above drive but also many other simpler uses.

- 10 The main power source can be any type of engine, machine or manual power. The high efficiency achieved by this system would be particularly beneficial to battery or solar powered systems.

- 15 There are many variables to the above system for magnetic control that would still come within the scope of this invention such as the use of metal filings suspended in a liquid or medium, used to actuate the clutch.

- 20 In yet another form of this invention, Liquid Polymers or similar may be used and may be controlled in any way to provide the above clutch action, such as changing their viscosity or density by varying voltage, current, temperature, centrifugal force, compression, or other molecular controlling means.

All the above described systems may be applied to any type of drive, motor, engine, machine, or manual operation.

- 25 In another form of this invention, exercising or body manipulatory or gymnasium equipment could equalise loading requirements using this gear to more effectively provide proportional leverage, for equalising, balancing and the reduction of size.

- 30 In one example very heavy weights must at present be used to provide a certain inertia combined with loading and cannot be duplicated by compressing springs, etc, whereas this gear could be used and in one method accelerate the cam drive

(which could be lifting a small adjustable weight, swinging a pendulum or governor) by manually levering the cage gear toward (or away) from the outer body of the gear. Rowing action could also be duplicated by the above action which could even have an impeller rotating in a container of water to simulate the sound and kinetic effect.

5 In another form of this invention gates, heavy lids, mattress, bed and patient lifting equipment can be manually levered apart at their pivot points providing extremely compact drives as there is great difficulty in providing power drives to this type of equipment, equalising and supporting using one of the three components to act as reference, or by using a second cage, FIG 7, 11, 18. Optionally the outputs can be equally actuated, using the bodies fixed or as references. For example, if two 6 to 1 contra-rotating ratios are required from two cages, one more number of body scallops and one less number of scallops for each of the two, six roller cages would be required. Any dynamic/reactive actions can be combined for transmissions or propellers.

15 The compact design of this planetary drive allows for a compact drive for contra-rotating drives for fans, propellers. There can be any chosen ratios, alternatively, it is expected that the input from the driving motor would drive the cam and the two output propellers would be on the cage and outer body. The blades could be designed in such a way that balancing would automatically occur or, a second cage could provide a reference for equalising, FIG 7, 11, 18. Ref pages 51, 55, 63, for one end propulsion. "Wheels Within Wheels" Page 71, "Ratio inserts" "Propeller pitch." The ability to store reactive energy within the windmill described on page 11 allows the increase of the duty cycle. Before the wind is strong enough to move the load, one propeller could force the other gain momentum opposite its normal rotation providing added torque the moment the wind increases to a point forcing the other blade to slow down. The option of contra-rotation to start, or when eventually the wind speed is reached, the ability to govern is also available.

25 This gear provides the ability to have a viable economic drive or a compact contra-rotating drive. This gear can provide contra-rotating propellers in aircraft or can be fitted easily now to stop the problems of gyroscopic torque reaction properties

30

caused by 'prop-wash' which can cause the aircraft to roll.

5 Propellers on fans and any fluid passing equipment can be made more efficient with this gear either in variable speed mode or in its contra-rotating ability, not only because contra-rotation is known to be more efficient in wind tunnel testing but because this drive can be made physically much smaller to restrict less of the fluid, gas or wind. High speeds and frequencies can be achieved because of the simple gear design.

10 Boat propellers can be made more compact and the varying of speed more easily achieved with this gear plus the gear has the ability to contra-rotate and balance automatically. If required the gear may be below the water level because of the ease of sealing this self-balancing propeller gear or, for example, a second cage could provide a reference for equalising, see FIG 7, 11, 18. A second gear can also be
15 installed directly on the driving motor in order to reverse the drive if required, perhaps with the use of an optional friction clutch, single or double action which may also provide "forward, neutral, reverse" as well as providing either a reduction or a 1 to 1 ratio.

20 This gear has the ability to provide a number of advantages in mechanical operations, for example, such as relating one wheel to another for equalising torque or differential action, or where one multi-drive or motor is required, or for four wheel steering. Another use is the ability of fitting a clutch to manually over-ride a motor driven auto-pilot on a boat, and will also allow easier installation of 'add-on'
25 auto-pilots themselves, as it is very difficult to find the space to fit a motor drive to the wheel on most vehicles. The added ability of being able to manufacture using non-corrosive materials in sea air equipment is a major advantage.

30 Another application of the gear with two contra-rotating elements with different angular speeds would be in the dispersion of fluids as spray for purposes such as crop spraying. The cage and the outer body could be caused to rotate contrary-wise

each with a turbine attached. Fluid could be forced out through nozzles, which exit the gear between the two turbines. The turbulence created between the two turbines would be used to atomise and finely distribute the fluid before it is ejected from the region of the turbine toward its target, producing a more even coverage of the target with the fluid than is possible now.

Any contra-rotating machinery requiring the passage of fluid or substance to activate and control the speed of the drive outputs can be fed into a central hole or orifice within the centre shaft. The orifice may be coupled to internal grooving within the gear in order to distribute fluid directly around the contra-rotating output vents in order to spray crops or equalise spreading or spraying of substances. Alternatively, a fluid hole may pass right through the gear in order to transfer the substance.

The ability to provide multiple integrated drives for example on ride-on mowers, the 6:1 ratio and 7:1 ratios could drive two contra-rotating cutting blades, plus the wheels could be driven at, for example, 36:1, all from one gear unit directly mounted on connected to the motor shaft.

The variable (or fixed) speed gear is a self-contained three dimensional, geared drive, with controllable ratios and built-in 'no load' start or clutch with automatic sensing if required.

Compared to existing gearing systems the variable speed (or fixed speed) gear will give the following benefits:

- Extremely efficient - up to 98%.
- Low friction with low wear.
- Easily mounted as it doesn't need critical driving or driven mounting supports.

- Can also be made of various materials such as plastics, ceramics, self lubricating materials, brass, bronze, inert tantalum, sintered steels or alloys, almost any material, and almost any manufacturing process such as cast, laser cut, machined. The designs can be very complimentary to be used with advanced technology in materials and manufacturing.
 - Can be made in varying sizes to suit many situations.
 - Can be completely sealed for medical or underwater use.
- Some designs only about 1/4 the size of others.
- Can be controlled in many ways to provide a variable speed much more efficiently than conventional methods of trying to accelerate a loaded motor up from a stopped position. The driving motor can be up to full speed, before the load is applied.
- Has an in-built ability similar to doubling leverage.
 - Has a feedback option.
 - Has a freewheeling option.

Yet further applications of the present invention include:

AUTOMOTIVE

- Variable speed gears could greatly simplify the present automatic gearbox. With the use of an electronic control (or other variable control) will enable smooth acceleration from small motors with barely any perception of gear change.

ELECTRO-MECHANICAL

Any system having high start up torque at low angular velocity will benefit from this variable speed drive.

An example here is the lift industry. Currently thousands of dollars are being spent on elaborate speed controls in many cases even requiring special motors designed specifically for the purpose of smoothly driving lifts. Smaller motors could be used in conjunction with this variable speed control either with an electronic type of control, or various other types of variable control. This would mean costs would be dramatically cut and still maintain smooth control of the drive system of the lift.

AERONAUTICAL

Smaller more efficient gearing would reduce weight and reduce friction in drive trains for aeronautical mechanicals. Vibration could be improved as well. Helicopter engine gearing would benefit substantially from this variable speed gear. Lightweight and maximum efficiency would benefit the space industry.

MEDICAL

Implantable orthopaedic prosthesis could incorporate miniaturised variable speed gears, ie. for skeletal movement in joint replacement. Materials could be inert tantalum, and together with a sealed gear would enable efficient performance.

MARINE

Gearing boat engines that give high torque could be easily met by the variable speed gear resulting in smaller size and better control. Small outboard motors through to big diesel engines would benefit with improved performance and reduced vibration and better frictional co-efficiencies.

INDUSTRIAL

Any system employing the variable speed gear would benefit from extra strength, especially in start up, high torque situations, and with ongoing efficiency and energy conservation. Low maintenance and lower manufacturing costs are other benefits.

DOMESTIC

Domestic products that are petrol, diesel or electrically driven would all benefit - particularly in the ecological area with the ongoing efficiency resulting in reduced energy consumption.

AGRICULTURAL

- 5 Reduced cost of manufacture, improved efficiency and reduced energy usage are all benefits offered by the present invention.

ROBOTICS.

Reactive touch sensitive control for robotics is possible by using the present invention.

10 **ADVANTAGES OF USING THE GEAR**

The multiple geared motors FIG 4, can either be fully self-contained or able to be integrated with external rotational forces, in some instances may be combined within, for example, a combustion motor (or other rotational source) crankcase and/or sharing the same shaft and/or lubrication Fig 8, 25, 26A, 28B.

- 15 Alternatively it may support the wheel (or load). Some optional additional design features follow on page 22 - 23.

FIG 9 shows a system for simulation and a method for choosing complimentary designs or for the manufacturing requirements for the rotational forces.

- 20 Integration of this gear with alternative, for example, hydraulics drive systems can overcome common overheating problems. The same integration can apply to the following train designs as optional alternatives.

1. Trains often use multiple electric (or diesel) motors, these motors can be allowed to come up to full optimum speed (or synchronous speed) before the load is applied.
- 25 2. The freewheeling ability of this gear can allow the motors to switch off when not driving. Power savings alone, perhaps over 70% or more should be possible if multiple motors are switched off.
3. The ability to retain an added braking system when switched off can be retained, if needed, by double acting magnetic brakes. This provides safer transport.
- 30 4. The gear provides integration with optional automatic load sharing or load distribution.

5. The present invention complements existing magnetic brake systems.
6. The present invention allows for the direct replacement of existing traction drives.
7. The present invention can be operated by electronic or manual control including handles, levers or push buttons.

Additional features of the present invention will now be described. These following pages, to page 24 line 6, describing optional manufacturing method of achieving the various choices of manufacturing some of the relevant designs, however there are many other variations such as described in this patent and the following drawings, Fig 1 to 30.

Electronic, Hydraulic or Molecular control offers design flexibility.

Either electric motors or hydraulic motors or a molecular coupling system could be used to control the gear ratio mechanism. The most efficient power to weight ratio could be attained if the machine already has a hydraulic system. Single or dual or more electric motors could be used to control, bias and drive the heterodyne gear. Internal or external magnetic controls could also be used to bias the gearing. The motor may not have any active parts rotating. Only the magnets rotate offering the benefit of no rotating connections to cause power loss from the output drive through friction. There are no power losses from frictional couplings of electrical parts. There is also the option of having coils rotating.

Few moving parts result in lower drag, within the gear. Therefore, minimal power is lost to friction and heat. It is possible for only one part to rotate within each motor, however refer to the multi-rotor motors fixed to multi gear shafts for huge efficiencies. Within the gear there can be few moving parts, however the ability to integrate, contra-rotate and parallel up motors is seen as extremely beneficial, especially if the entire motor may be supported on a common shaft within the electric motor (Refer to Fig's 3 to 30 herein) with internal gear (EMIG), thereby reducing internal drag. Reducing drag internally reduces the heat generation within the EMIG. This allows the EMIG body to be manufactured from lighter materials (which usually do not have good heat transfer characteristics). Less mechanical parts meshing, results in less power loss within the gear.

It is possible to spin up the two (or more) motors at opposing high frequencies without the output drive moving, then control the frequency of motor (or motors). The resulting output from the heterodyning gear (which is mixing these two frequencies) will be to produce a low frequency, high torque force at the output drive shaft. A physically smaller gear has less weight.

There is one major limitation of 99% of all electric motors. Inherently electric coils have a small delay time from the moment when power is applied to when the magnetic force is delivered. This small time is constant (only dependent on temperature) but at a specific R.P.M. will equate to 1° of rotation. Therefore, maximum efficiency can only be attained at one R.P.M. All other R.P.M.'s are not as efficient. The microprocessor control possible with the present invention can move the pulse timing anywhere, and could easily track the most efficient angle relative to the current R.P.M. Microprocessor control increases the power efficiency resulting in less wasted power within the gear.

Since our microprocessor has total control of the switching times (phase angle) of each pole, (as per above) whilst regenerative braking the microprocessor can track the most efficient timing depending on the R.P.M. to produce the maximum power out of the gear and will stop the output drive as fast as possible. Auxiliary brakes can thus be downgraded, again reducing the overall weight of the product.

There is no need for a clutch within this unit thereby reducing weight and wasted power within the gear whilst interrupting the drive mechanism.

Since the gear is infinitely variable the output drive can be accelerated from stop to any speed smoothly.

Several aspects of this motor have improved the power efficiency of this motor-gearbox, thereby reducing the need for a larger size. There is less power loss from not having frictional couplings of electrical parts or mechanical meshing of gears or

clutch. Also there is a power gain from a more efficient control of the electric motors in acceleration and braking. There is less heat generated inside this gear and so requires less cooling. All of those factors allow the gear to have a smaller size which then has more surface area per kg, thereby increasing the cooling effect per kg and thus reducing the weight of the cooling systems and the overall size requirement. Reduced size is reduced weight for the same power output.

Further discussion on certain prior art and the improvements thereto offered by the present invention will now be detailed.

Another advantage is a computer simulation programme for the CNC machining of scallops so that the fan rotation direction will change the normally symmetrical shape of the scallops to allow for the directional and/or dynamic momentum wear. Another advantage of the present invention is the multiple ratios provided, as illustrated by the multifunction cage in FIG 6B which has a cam integrated on its back for the next stage of rollers, the ten scallops by two sets of nine rollers giving a 81:1 ratio within the same body. If the same is duplicated with, for example, eight scallops and seven rollers, all on the same shaft, a lower ratio is provided. The compound contra-rotating action offered by the present invention should find use as FOUR WHEEL STEERING (FIG 5) for vehicles (ie, if the rear wheels require a lesser turning circle), or for power assisted steering or even to equally turn the wheels for a vehicle to go sideways or for angular parking or similar. The gear can be conveniently supported by the outer body. Of course, just a simple single reduction would be necessary if it is used as steering or equaliser for invalid mobiles, ride-on mowers or similar smaller-type vehicles. If necessary, vehicles such as trucks may require different ratios for wheels to turn in the same direction. The four wheel steering or sideways motion, can be for any type of vehicle, and further the planetary drives can be remotely controlled together with auxiliary motors driving the wheels of trailers or similar.

The present invention finds application in electric motors and electric motor design which can provide motors as shown in FIG 4 to be tested by simulation (FIG 9).

5 The present invention improves the action of magnetic clutches; improves regenerative feedback through application of the contra-rotational shaft with the outer body; integrates, sums and subtracts rotational forces; has the ability to produce and vary any required rotational force which results from integrating varying input rotational forces independently accelerated in a method suitable to optimise their design.

10 FANS A prior art Fan Company's publication claims contra-rotational exerts up to 2.5 to 3 times more pressure in a wind tunnel. In order to achieve the most relevant speed to the fan industry, it is necessary to start a load efficiently as near to a 1 to 1 ratio so as to have sufficient R.P.M. when using standard 50 cps motors. The present gear invention now makes this possible by at the same time also
15 substantially reducing wing tip noise (FIGS 3, 4, 7, 11,18). It may be possible to contra-rotate propellers on the end of a motor using fluid flow to balance them with our planned propeller designs. However see pages 37, 51, 55, 57 and others for equal contra-rotation and control by formula or by calculation with many variable options. The contra-rotation also has applications in the propulsion of any land or sea
20 craft and aircraft. (FIG 3, 4 7,11,18).

Previously, such action was considered too costly. However, because of the optional roller design of the present invention which provides a choice to use only one (or more of each) rotating discs to combine and contain, for example, a planetary cage, a motor rotor, or set of coils, an outer body for the next stage, a row
25 of magnets, and, for example, a cam (sun gear) for another stage, such that advanced features are more economically viable.

This invention also provides a device to provide or include a type of biasing, ramping up or fast acting rotational energy storage mechanism which allows
30 optimum torque to be gained by any internal or external rotational force when stepping through discreet gear systems.

By arranging at least a second roller (FIG 3) cage in a 90 to 120 degree angle to the first roller cage, it therefore also requires at least a second cam to be at 120 to 180 degree to the first. Fitting rollers which will allow the compact movement has also been overcome by providing a step along their length so as to pass over the adjacent
5 cam and thereby allowing for the option of a tension spring to control end play and also provide an optional wear reduction feature by tapering (for example) the outer body when machining the scallops.

The rollers also all move in the same direction as the surface they are in contact
10 with.

Four Wheel Steering

Transmission in FIG 6 is bolted to the chassis in order to provide contra-rotating outputs. There further being the ability at the same time to provide a lower ratio (or
15 higher ratio) which could be used to activate other features automatically such as altering caster or camber at the same time at a complimentary ratio, or perhaps as the wheel turns, things like the body of the whole vehicle can be tilted automatically without even using electronic control.

20 The above actions (reactions) would be like the touch sensitivity referred to in my Provisional Patent such as the slope on the road requiring heavier or lighter steering due to say the camber needing greater force or perhaps the feedback from greater tilt of the vehicle.

25 Also robotics have the ability to say bend an "elbow" automatically when the load exceeds a chosen weight, or a load can be allowed to be lifted at half the speed simply by the feedback.

Not unlike the tendons in our own body, however the body of this gear would not be fixed from turning when applied to the "elbow" type of operation, and could be also
30 referencing some other point even in some similar vehicle steering designs.

The ability to provide high ratios and/or multiple low ratios 6A,6B, within the contra-rotating cages together with the ability to have the main input shaft turning in the same direction as the output shaft so that it is only necessary to have a simple extended range clutch on the feedback cage, in order to have a complete linear automatic transmission. See Fig 6A,6C, 6D, 8. Both wheels may be catered for as shown in the drawings.

The rotary compression ability by displacement by, for instance, designing the suitable shapes into the rollers/pegs/slides/or similar, the length can be any suitable requirement to allow for travel of the "stroke". For example, these may be like pistons, with the ability to interact with porting for the input and exhaust through the relative chosen part. The ability to have a stationary cage for these purposes is also convenient, which can allow for inlets and outlets – see Fig 7.

Combined transmissions able to linearly gear up to a 1 to 1 speed using clutches alone, or electronics in many variations, as described in this patent.

The design can incorporate hydro-static operation combined with internal or external accumulators. And can be totally performing as a geared, high powered transmission.

There is the ability to combine with any type of fuel or fuel cell, or work in a double or multiple power system providing regeneration advantages. For example, the first motor may be limited to the optimum fuel cell capacity whereas a second motor may provide high torque and other advantages herein described. There are many hybrid and high torque options such as those in the drawings herewith. Most features described in these designs are feasible with the use of multiple cages designed to suit each requirement, however there are other optional ways described in this patent to produce linear and high torque transmissions.

The range and efficiency of all powered machines can be likewise extended in the various methods that are described in this patent. Contra-rotation can be used as described to achieve extra torque efficiencies.

5 In many cases, the range provided by FUEL CELLS are dependent on their capacity which can be greatly extended by incorporating other of these ideas in this patent, such as —

An advanced drive can also be constructed, by placing a planetary gear assembly similar to that used in the simple Internal Combustion Hybrid design,
10 thereby giving the system a higher efficiency by allowing a regenerative aspect. (This is on the basis that a hydrogen cell is not efficient at recharging at these conditions). For example the "E" Hydrogen type energy, would be greatly benefited if the fuel cell motor is driving into the input cam of a planetary gear, then, by using a regenerative feedback motor connected, in line, preferably,
15 (which could be powered by a Li + Lithium Ion battery supply) to the outer body of the gear. (The output could be taken from the planetary gear cage.) This would provide many advantages as described herein, and would further provide a total transmission. There is the option of the second output to the second wheel as well. Including a reverse gear.

20

As described, the Gears can be made in various configurations, and the power transfer through the roller type gear can be enormous, particularly if the multiplication ratios are accessed. Many advanced materials may be incorporated and varied to suit each application. For example, there may be
25 requirements for high speed materials, or light weight, heat resistant, or combined steel and ceramics and so on. The ability to integrate the systems providing compound linear and/or high torque transmissions. The transmission may be totally enclosed, the easy mounting abilities for providing complete integration of multiple source inputs, combinations of machines are endless.

The roller can be any shape described as /ball/peanut/shaft/or pump actuator/piston with built in con-rod, compressor). This compressor of course can be a multi-cylinder rotary compressor / engine, which is in progress of manufacture, and being designed with porting and timing at this moment. The ability to build in and laminate other compartments side by side to incorporate – Built in Gearing, Multiplication, Accumulators, Compressors, Rotary Combustion Engines. The added ability to provide additional gearing can have huge multiplication, if chosen, can provide complete, self-contained multi-function, high powered machines. Revolutionary integrated devices can be made with all these operations on the same shaft/axes, at the same time combined with the ability to turn the outer body. The outer body can enclose everything such as pumping, generating, or connected to the wheel / load itself. Input and output can turn in the same direction and on one same axes, making possible all of the options for all the numerous methods described in this patent.

The ability to build in a stationary cage for entering and exiting the various fuels or liquids is also described in the two cage drive for contra-rotating fans, Fig 7, any chosen ratios can allow for example, the output of the machine, taken from the outer body (or laminated outer bodies) or from a suitably dimensioned cage or cages.

It can further be designed to combine three dimensional types of reactive actions which not only feedback from its own actions, but as a result of, for example, a car rolling due to the road camber changing. The torque doubling feature is automatic to all operations, providing compensation for any slight frictional losses, which themselves are not there as the transmissions near optional 1 to 1 ratios.

HYDRAULICS

Hydraulics can be designed into the internals using methods such as pressure, pressure equalising, displacement, or vacuum. Hydraulics and gas are highly

complimentary to this drive, internal or external hydraulics is optional, as also with the optional hydraulic feedback control. In requirements where lubrication is not provided, or chosen by the use of ceramics or other suitable materials, it is extremely beneficial and complimentary to combine either internal or external
5 hydraulic operation and/or control with the roller gear option of this patent. The ability of having linear drives or steps in ratios is also optional, hydraulic pumps should provide compatibility with this patent, in some cases these may only require modification to achieve the feedback sensing described in this patent.

10 The ability to use or combine advanced materials or such as ceramics is also unique.

In one example, the transmission can have the feedback cages for two loads on either side of the drive (transmission and/or hybrid drive), the whole assembly
15 can optionally be supported by one shaft. Another example of compactness available by accessing the feedback available from this gear is, for example, a double-ended motor with a common shaft supporting the gears on both ends, which can have the feedback cages controlled, by electronics, hydraulics or any other above means such as centrifugal clutches or coiled springs and would
20 provide a compact two wheel transmission.

The ability to combine added wheel spin control is also seen as a great advancement on the Patent 607822, 1987. This patent for the control of relative rotation speed over about 14% rotation of each other, has been assigned to me
25 by the inventor who was awarded a bronze medal in Geneva.

Another advantage is the ability to allow the driving force/s to reach optimum chosen speed before the feedback is actuated (in one of many ways – see patent) to provide chosen rotational torque. The feedback has the ability to
30 integrate rotational forces by directly sensing them and making the prearranged

corrections directly or indirectly. Another advantage is the ability to run back and forth in any chosen method in order to access dynamic momentum to optimise or boost any action chosen, see page 2 of this patent.

- 5 This patent is extremely compatible with the latest developments such as with fuel cell technology, and can further revolutionise transport in every aspect.

10 This patent describes a three dimensional device which can provide everything from High Powered Linear Transmissions, for driving anything in a compact revolutionary way, accessing feedback through a simple new "pulley" system - to supporting the passengers in a remarkably luxurious way by feeding back to this alignment correcting device. This device has the further unique ability to support some paraplegic people or invalids in an upright position, and also the number of listed uses shown in this document.

15

The device can control any mechanical load, using feedback from the load itself, using some three dimensional variations. Due to the vast number of products able to be revolutionised by the strategic application of this device, this patent can be enormous.

20

Another application is lifting a load according to the weight, for example if another cage is added, the cage can be used to feedback from the lifting method used, for example, a rope can have the reactive cage (or body) lever out a pulley which will cause the rope lifting the weight to be lifted at a more acute angle to cause the other side of the planetary pulley to change its relative lifting speed. This same action can be applied, for example to bicycle chain gearing.

25

It was when I saw a newspaper article of a resourceful man with a Geneva award-winning differential invention, which included a very compact, versatile, planetary type operation, that I had success.

30

THE MOST SIGNIFICANT PART OF THIS INVENTION.

If a very large load is directly coupled to a power source on one shaft, the power source could not normally allow the heavy load to start turning in order to reach running speeds or a 1 to 1 ratio as this present development can. This invention is further able to provide this ability in one body or even without a body. Normally, there needs to be a third totally separately designed item, which needs to provide some means of mechanical coupling to an isolated gearbox. These are bulky, requiring large structural enclosures, or alternatively huge electrical loading losses are expelled and wasted. Two of the best examples of coupling a load on one axis follow, though when this is achieved, they provide very limited application, and are cumbersome. Reference is made on page 1 of this present patent to Patent Aust. 465202, (53,497/73) "Eaton Freewheeling Two Speed Motor Wheel" which uses hydraulics and a planetary gear set. Refer particularly to their Claim 1. This extremely powerful design was achieved only because of the ability for a hydraulic motor to provide rapid reversal of direction and braking with a solenoid clutch thus providing the motor drive with a powerful first reduction gear ratio. The motor is then reversed with the combined actuation of a second clutch in order to provide the plurality of speeds. The REVERSING ability of these hydraulic motors being the key.

The greatest advance of this present Patent can provide enormously high torque in one single body, on page 4 there is described a yo-yo type of action which can revolutionise all transmissions as follows. The torque curves in Fig 2 of the French Pat. 74748/91 show the extremely high torque available on the first transition to a one way clutch, using a single rotational power source, though they cannot put their transmission in one body and it has a cumbersome separately rotating planetary configuration. Page 4 of my Patent describes the further ability to achieve the extremely high torque operating dynamically like a yo-yo in one body, though operating now on one axis, Ref Fig 4A, 6, 6A, 6C, 6D. Further because this torque is achieved in one body, on one axis, self regulation is able to centrifugally regulate and control speed by the intrinsic self contained fixed ratios or by added centrifugally actuating means with the variable clutching of this high ratio integral second planetary component (cam, or sun-gear). (There is also the alternative of using multiple inputs as shown.) This analogy of the yo-yo, substitutes gravitation providing dynamic momentum for the input rotational force. When the yo-yo reaches the end of the string with the maximum dynamic momentum, it automatically provides the REVERSAL of direction which represents the first transition. This action is now duplicated and achieved on one

axis by using the one way clutch to frame/ground providing the REVERSAL, which allows the chosen ratio for maximum torque to the load for the first transition. Clutches such as sprag, roller, brake reversible or controllable clutching by any means can be used. The second powerful transition can be similarly shown as in the French patent Fig 2 torque curve, but now is also able to provide maximum torque and speed automatically. The continuing analogy of a Yo-Yo may be likened to a fishing rod and reel being manually levered back until REVERSAL of direction, for the first transition, and is now able to achieve the second transition likening it to winding in the reel. There is the resulting continuing control of the torque curve with linear acceleration. The ultimate aim is to provide a smooth power output.

The French Patent 74784/91 is also referred to in this patent and within the "Wheels Within Wheels" pages 66 to 72, particularly note items 3,4,6,9,12. because this patent used the REVERSAL of direction to achieve the high torque. However, they used standard, separately rotating planetary gearing to function, whereas my invention does not even need a body, and is therefore a "Historic" breakthrough. This present invention can be inside and part of the driving source or part of the load, or supporting one or the other or both of them.

There is the very great advantage of being able to control feedback from other axis such as described in the car leaning descriptions and the paraplegic support types of applications refer to Fig 12 which can be combined with Fig 5 steering for camber and caster together with controlling the leaning referencing any axis because of the fixed relative gear ratios of the multiple differential. It should be repeated that the fixed ratio gearing of the double ring gear between power source and load allows for a secondary enormous advantage in that self-governing and centrifugal controlling mechanisms are now able to simplify all transmissions, this feature again is a further "Historic" break through. Refer again to the Yo-Yo action in this present patent page 4, as also shown in Fig 4A, 6, 6A, C, D.

The ability for a single input rotational power source to provide and combine high torque on one axis as well as fixed ratios in one body with self regulation had never previously been found. The ability to accelerate a cam (sun gear) has been described in several places, as they were needed to provide dynamic extensions for high ratios as well as cage/cams needed for low ratios. Interconnecting a variety of ratios has been an important feature in the alternative roller planetary design with many ratios described. Such as using cams with cams, cages with cages, cages with cams, bodies with bodies and/or cages, with

multiple ratios and the ability to integrate planetary gearing. Fig 1 shows the unique ability to achieve a REVERSE planetary cage for planet carriers by having one less roller than scallop, instead of the common planetary forward planet carrier as with toothed gearing. This unique REVERSE planetary ability allowed the extension of this enormous potential ability so as to achieve single axis transmissions with high torque in one body as follows.

5 The biggest breakthrough came with the ability to couple together two planetary carriers (cages) as has been shown and explained in Fig 4A, item D6 which shows a torque multiplier configuration and is shown in Fig 4 as D6 and Fig 6 which shows two cams No1 inner cam 3a and high ratio output 3b. These are more clearly shown in 6A, 6C, 6D.

10 Alternative examples of concentric operation with cage cams able to be integrated with the multiple cage/cam uses are shown in Fig 6B. When the first PCT Patent was not able to be applied in time for this major original mechanical development, a second Provisional patent was applied which totally enclosed the first Provisional Patent pages as from the fourth page of this second Provisional, up to the alternative electric motor development designs page 22

15 - 24. The Fig 1 to Fig 4 was retained with the electronic advancement of heterodyning, with the words 'RPMLO' added to the previous differential wording on Fig 4 "with the original drawing 4A showing a multiple differential. When the second provisional patent was put in, in order to not confuse the major mechanical advancement, an electronic motor enhancement which showed the addition of electronic control for some mechanical drives,

20 "Super heterodyning", (see this patent page 45 line 21-33.) Further heterodyning was shown also in the Fig 5 drawing of the Provisional Patent together with alternative one way clutching positions of this transmission. This was drawn with a roller design to show the similarity to the French configuration of their Fig 5 transmission in its similar ungainly original form, the drawing Fig 5 is shown here as originally filed both with the other Fig 5

25 four wheel steering drawing, which shows the versatility of the roller design. It is also on the Page 20/31. This drawing was put in to show the understanding of the duplicating ability, and it was therefore drawn similarly. See Provisional Pat. page 1 E lines 11 to 16. This describes the new Electronic advancement and then goes on to describe the previous mechanical provisional patent enormous abilities. "In one form of the invention, there is the

30 option for any or all of the three basic components of the planetary gear to support electromagnetically controlled components in order to provide the heterodyning requirement, however there is the added complimentary ability to pancake our gear with or without an

integral second planetary component as shown in drawing Fig 4, which could capture multiples of extra contra-rotational torque described herewith, plus also providing interface abilities for combining any required or programmed performance from hybrid type inputs,"

5 The reason that the French and the Eaton Pat.465202 referred to above are so effective is likewise because of a REVERSAL of direction between the first and second transitions. The French show this in their torque curves in their Fig. 2 which refers to their Figs 3, 4, 5. The first extremely powerful transition is achieved by having the gear ratio working against the one way clutch to frame or ground. The high torque achieved then carries on to the next powerful transition which is therefore easily achieved because this configuration also forces
10 the second sun gear to provide a faster rotation speed which causes a multiplying effect to the sensitivity of the torque and speed control between input and output awaiting the second powerful transition which is achieved because the ring gear automatically REVERSES direction in relation to the frame/ground thereby releasing from the ONE WAY clutch/brake to the frame/ground because the coupling of the centrifugal clutch continues to pull it in the
15 forward direction. Refer to their more adequate description. See item 37 and item 42 of the French patent, also see equivalent item 41 on D6 Fig 6A of this patent. Refer

... particularly to their Page 5. (The similar one-way clutch is numbered 37 in my Drawings 6A and 6D, with item 41 as my alternative clutching point/s.) However the French invention must have two separate planetary ring gears to achieve the high torque, comprising of at least FIVE separately rotating components with one reverse rotating ring gear coupled to the second planet carrier providing the reverse rotation essential for this invention. However my invention only requires FOUR separately rotating components in ONE BODY. In order to access the high torque from the reversing action, the French patent describes a one way clutch to ground on their second ring gear allowing the gear ratio to provide maximum torque, as seen as their Fig 2. This first step forms the basis for their three claims 1, 2, 3. Refer also to their whole patent and, for example, to Fig 5 further described below. There is shown the first ring gear (crown) here fixedly coupling its reverse rotation to the carrier of a second set of planetary gears referred to as a speed reducer, with associated second sun gear and second ring gear (crown) having the described one-way clutch to ground. The second ring-gear cannot turn, therefore the second sun gear and a clutch element to which it is fixed rotate with an increased angular velocity relative to that of the first ring gear (crown). This multiplication of the angular velocity increases the sensitivity of the device to changes in the engagement of the clutch elements of a second clutch, items 107/108. Their action thus provides continuing torque to the load, in order to achieve their variable speed transmission, described more adequately in their description.

This present Patent provides an enormous advance in technology and has been achieved by similarly providing extremely high or even better torque, however this is now in one fixed ratio multi-configurable differential system. refer to Fig 6A and also 6D. This alternative roller gear design is also able to provide many advantages over the toothed transmission, such as compact multiple concentric abilities., providing multiple feedback and controlling abilities. This is from and too not only the one axis, but any other axis for third dimensional interaction with any number of multiple differentials. However comparison is shown here by the incorporation of this new technology as applied to Fig 5 of the French Patent following. The One way clutch item 37 is shown in both Patents and item 41 is the alternative shown in my Figs. 6A and 6D. This invention is now able to be achieved here within one body (by coupling their two ring-gears together) and can be more easily explained by including an added REVERSE rotating planet carrier to their transmission. This is fitted between their other two planet carriers of the French Patent, forming a DOUBLE REVERSE direction carrier by fixedly coupling it to the carrier nearest the input source, or left side, now achieved by disconnecting carrier coupling 19 from their

present ring gear 16 and fixedly coupling it to the new double planet carrier by the same link 19, instead and further, extending and fixedly coupling their ring gears together in order to provide central teeth for the added planet carrier, which also requires the extending of the sun gear teeth, item 14, to likewise provide drive for the new extra double planet carrier
 5 between the other two planet carriers. The one way clutch can remain as shown on the ring gear to ground, or there is the further enormous advantage of being able to take the load from the ring gear/body. This DOUBLE REVERSE rotating planet carrier/cage can now similarly be controlled by the one way clutch to ground or frame, in the same way as their ring gear is shown to.

10 There is the added advantage of being able to divide up the very powerful first torque stage shown in their Fig 2 and providing three added steps of fixed speed by progressively latching the first gear ratios. Or choosing the required ratio, for example, by one way clutching the three separate components to ground/frame. Alternatively, various braking and controlling methods can be used, such as body first, then the double planet carrier, and
 15 next the high ratio sun gear.

(If the roller alternative is used more cams or cages can be added to provide more steps or ratios in the roller gear with more concentric alternatives. There being very large diameters available for inputting and outputting rotational power.)

There are now further reversing of load alternatives available within their one body
 20 from either end by adding suitable double planet carriers and sun gears. The load can now be coupled to the body with the one way clutch to ground now taken from the double planet carrier. Therefore reverse gearing for their load shown at item 52 may be replaced and can be in one body. (This powerful reverse drive of a load can provide highly powerful braking and by also controlling the momentum of a load.)

25 There are further enormous advantages because this one way clutching is available to control from both ends and now providing extreme versatility (particularly if the roller gear alternative is used. An added centre shaft fixed to ground can be used for alternative support of the transmission or, for example, supporting a wheel and is also able to conveniently provide the necessary one way clutching to ground for the first stage. Various
 30 types of self releasing clutches can be employed for the first powerful step and are releaseable, reversible, automatic or manually controllable. These clutches can be in many other positions. There is a further advantage of being able to have either a one way clutch

on the planet carrier with a chosen ratio or there can be other reduction ratios from the high ratio cam/sun-gear if chosen. These high ratio sun-gears can provide forward and reverse direction to the load and control from either end, there is also ability to have multiple combined ratios within the same planet carrier. Many types of one way clutching designs are available some are such as are described in the Patent 607822 assigned to me by Arthur Woodbridge. Which shows and describes examples of a variety of clutches such as sprag and roller types. Alternatively manual or manual override control and clutching/braking can be used. There further can be controllable clutches of any type or such as are described in the French Patent. There are alternatives for controlling shown from engine vacuum and other motor controlling methods described. There is the alternative of low cost yet sophisticated electronics which can enhance the transmission for optimum performance. A motor brake can similarly be applied with a one way clutch as shown as their item 26. There are numerous other clutching operations for control for continuing the torque curve and bringing the transmission up to the 1 to 1 or required ratio. Liquid polymers in silicon oil or any other forms of similar radiated or inductive and magnetic control can be used. There are many alternatives such as internal pumps described which can work like a torque converter. With a one way step to the ground/frame first then having a pump as the next step which can be working with a second pump like an impeller or motor between any of the rotational components, preferably able to provide centrifugal control such as between the 3b cam rollers and scallops. The principal of the basic model is very simple using a single input source, by providing a geared first ratio up against a one way clutch/brake as shown in the French Patent. The torque curves show the very powerful first stage which may take the load up with, for example, a 1 to 5 ratio, next the torque multiplying action can now take advantage of the automatic (or controllable) releasing of the one way clutch. Various clutching or pumping actions can now take up as described, bringing the load up to 1 to 1 or any chosen ratio. There are many variations available, for example, de-activating and controlling the one way clutching so that, for example, an input source can be idling without driving the load or moving it forward. This transmission would be able to advance many patents, for example, the French patent and the Mitsubishi Patent No EP O 794 360 A1 provided in the International Search. This is because this transmission can be self contained thus able to provide means to integrate automatic regulation and control because the input source and

load speeds are directly related to the rotation speed of this transmission. These one way clutches can be sequentially or progressively actuated or de-activated, are releaseable, controllable, reversible, and able to be integrated with internal and external regeneration and accumulation as follows. The large displacement between the rollers and the scallops can provide compression and pumping by design.

As well as the advantages shown for the methods above for a single power source input, multiple internal or external storage of energy with this planetary configuration can similarly benefit. Multiple power sources, which can add together and are able to be integrated or run independently at the same time as each other, on the same transmission, for example, continue operation when one energy source expires.

This versatility can be described as follows:

MULTI INPUT-OUTPUT FIXED RATIO TRANSMISSION SYSTEM

FIELD OF INVENTION

THIS INVENTION relates to an improved, user-defined fixed ratio, transmission system with multiple configurable inputs and outputs.

BACKGROUND OF THE INVENTION

The transmission of mechanical power from an energy source (usually an engine) to drive a mechanical apparatus is well known to be able to be achieved in many ways. There exist many common applications of this, such as fans, motor vehicles and windmills.

Recently, however, there has been the need to transmit mechanical power from more than two energy sources to a single (mechanical) output. Applications of this include such innovations as Toyota's hybrid petrol/electric car.

None of these recent innovations, however, has been able to solve the perplexing problem of dynamically configuring the inputs and outputs (I/O) of the system. This ability, that is of dynamic I/O configuration, is required before many real applications, such as hybrid transmission systems, can produce real and useful results.

ANOTHER OBJECT OF THE INVENTION

It is therefore an application of the present invention to produce such hybrid transmission systems that can be used as solutions to real-world mechanical transmission problems.

Low cost sophisticated electronics are very compatible with this transmission, in some cases micro controllers can be extremely complimentary.

SUMMARY OF THE INVENTION

"This invention relates to devices for the transmission of rotational power in the form of rotational motion", please refer to page 1 of this document.

This invention has been described as a "Pulley" System by a Professor. Though it has fixed ratios it can however perform dynamically providing variable speed and is further able to provide multiple integration and control on the same axis to achieve third dimensional reactive control and feedback operations in many different methods.

DRAWINGS. Multi input-output fixed ratio variable transmission system.

FIG 1. As stated in my Australian Patent No. AU-A-93246/98, Pages 1 and also page 31, Australian Patent No. 607822 (25125/88) "Spin Control Differential" has been assigned to me by the inventor, Arthur S.A. Woodbridge..

Fig 1 is a copy of one of Arthur's original drawings. Note that the names given to these planetary components and operations are in many cases our own, being new technology, there was little to compare the operations with and it was further necessary to develop it in secret. This planetary cage is able to provide internal reversal of rotation direction due to having one less roller than scallop. Forward rotation with one more roller than scallop is optional, or it can change direction of rotation by choosing relative numbers of rollers to scallops, combining cages with cams, or cages with cages, bodies with bodies and/or cages, cams with cams. Many alternatives are possible. The planetary gear is shown as Fig 1 in both Provisional Patents, and Fig 1 in this patent AU-A-93246/98 is the same as "P.C.T.AU99/00452" also see also pages 66 to 72 "Wheels Within Wheels" in both patents.

FIG 1. For most of my life I had been searching for some three dimensional ways to control loads automatically on one axis by feeding back from the load in order to automatically make reactive corrections for static and/or dynamic requirements. Arthur Woodbridge, the winner of a Bronze Medal in Geneva in 1987 discovered a type of third dimensional feedback by relating one wheel of a vehicle to the other wheel and controlling it on one axis through the feedback reference from contact with the road, thus providing effective yet limited use of one feature. Further, he discovered that planetary gear cages 6 could go backward or forward in the same body 5 by having one more roller 7 or one less roller than scallops 9. In his patent, Arthur further described that optionally, double rows of cams 3 and rollers 7 and other optional methods of using planetary transmissions and planetary gear components can be used.

The heart of this invention lies in the resemblance of a "Pulley" system which was described by a professor as being like a figure "8" which he traced around and around in varying diameters. After reading my information, he picked up the polyurethane cage and body

prototype parts and the cam, which was able to show internal reversal of direction in the free-to-move body. This is described in the PCT, see page 32 line 22, also see Australian Patent top of page 28.

The third dimensional feedback in this invention can control statically and/or dynamically in
5 amazing methods.

Driving a car like riding a motorcycle, Fig 30 shows two separate planetary gears, of Fig 6 B or 6 A and 6 B, or any required combinations coupled between the two sets of the wheels as shown (looking end on) in Fig 12. As the chassis weight causes the car body to tilt into the corner instead of being thrown away from the corner as at present. The wheels also lean
10 into the corner and can be continuously corrected by any means.

Fig 6A and 6B are likened to showing the invention from an "internal view". The controlling of the car wheel and body leaning operation shown in Fig 12 is likened to showing the invention from an "external view", and has also been confirmed. by a professor. However, Fig 30 is the view showing the car tilting into the corner using three dimensional
15 feedback, together with any required camber alignment and/or control. There is however the further ability as shown in drawing 30, where the leaning of the body of the car can provide reactive feedback in order to assist reactive corrections automatically and continuously. Fig 5 can also achieve some optionally complimentary third dimensional features, with, for example, controlling the steering in any chosen method with the added
20 ability to provide any automatic or controlled correction for example castor control, or any other combination abilities which can be controlled reactively or combining simple yet sophistication by micro-controller control. It is shown with the ability to control and support everything on one axis, a basic resemblance which is similar to what was controlled in Arthur's patent, from reference from the two wheels to the road.

Fig 5 shows the four wheel steering with some amazing options and abilities, however it can further similarly be controlling in methods described, making third dimensional corrections to other chosen reference points, for example any other complimentary third dimensional combination with the above body tilting operations as well as correcting caster. (as described at the bottom of the Fig 12).

The paraplegic person of Fig 29 A shows the ability to provide equipment to correlate and reference positional holding using this inverse feedback. For example, with a paraplegic person in an upright position, the gear can also simulate muscle and ligament movement with touch sensitivity. It is able to be optionally controlled by a gravitational sensor, or similar, which could be at the high point of the spine. A resemblance of walking (for
35 example) could be provided if the gearing controlling the waist at the back, this could as

well reactively cause to pivot the waist pushing it forward. This could be combined with assisting the weight to be transferred onto the right leg, so as to allow the left leg to be lifted. Many different variations are available with the multiple options in this transmission. Robotics can similarly benefit.

5 Overseas developments of similar planetary type gearing of the time were in Arthur's possession when I met him. These claimed extremely impressive engineering figures also showing that this type of gearing could be $1/5^{\text{th}}$ to $1/3^{\text{rd}}$ the size of other relative gearing, (which were further confirmed by a professor). These included photos of large machinery with similar designs to Arthur's planetary gearing, as shown in Fig 1 in my patent. Arthur
10 had shown the overseas people his patents and had tried to obtain supplies of their gears, however, they perhaps realised he had patents and wouldn't supply. However they state emphatically on page 8 and 9 in their comprehensive engineering description that, "The roller drive mechanism, besides only being manufactured as differential device, can not be made for variable speed governing". They go on further to describe the use of coupling
15 these similar planetary gears to another manufacturer's "cumbersome tapered cone" type of variable speed mechanism as pictured in their description.

The uses for this multi-purpose product are endless. Furthermore, it has the potential to replace or interface with many other complex devices, due to the unique type of three dimensional operation providing balancing, feedback, biasing and types of vernier and
20 heterodyning features. The size of this product can be micro to macro depending on the type of computer program used which simplifies design. However, in some cases, toothed or any alternative planetary gearing and pumps can be substituted for the roller type planetary gearing.

One simple ratio doubling experiment I demonstrated, was by lifting a load with two ropes
25 from opposite sides - one from the body 5 and the other from the other side on the cage 6. The load was lifted requiring twice the number of turns of the cam 3 and twice the time taken than what was needed when lifted with one rope, by locking either the body 5 or cage 6, (because the body 5 and cage 6 had been "winding into themselves"). This feature could also be complimentary and enhance the contra-rotating features of this transmission.
30 Furthermore, in Woods published wind tunnel tests, contra-rotating fans have now been found to be 2.5 to 3 times as efficient as a single fan. This could further benefit in many methods described in the patent, for example, by calculating relative ratios providing equal contra-rotation and/or multiple stages. (One optional method uses 6 and 4 scallops with 5 and 3 rollers in two contra-rotating cages, thus providing equal contra-rotation by holding

the 5 cage stationary and having the loads coupled to the body and three roller cage.) The ability to further control the stationary cage is available, together with further control of the 6 scallop body being available if the load is restricted to the 4 scalloped part of the body. Pitch control can be controlled through the centre shaft. Swash plates or similar can be used in the best engineering manner, to provide guidance or any other requirements. See page 51. Woods further say, "From this arrangement, additional contra-rotating stages can be added with successively higher pressure development capabilities." This is very complimentary to the multiple configurations available on this roller gear option. I could feed back from a load in the type of three-dimensional methods described in this patent, to operate a resemblance of a "pulley" system, on the same axis. For example, by contra-rotating and/or, by allowing a cage 6 to go backwards in the body 5 and controlling it in any way, allowing the body 5 to rotate, could bring the gear up to a one to one ratio, with any chosen ratio, providing extremely simple and compact transmissions on the same axis. There are many further torque advantages, see Wheels Within Wheels 1996 items 3,4,6,9,12 referring to French PCT 74784/91. The French PCT is totally revolutionised by substituting their planet wheel 14 with a cam and their crown wheel 16 with a roller scallop body coupled to their crown wheel 31. Then by replacing their carrier 18 with a suitable reverse rotating roller cage and coupling it directly to their satellite carrier 19, thus providing a great advancement that now only needs a single body, from which the load can be coupled as well. See Fig 8 of Mitsubishi Patent EPO 794 360 A1, which can also be revolutionised. See Fig 6D herein which can provide pumps and everything needed inside one body. One example of the "pulley" system, is a windmill, described in this patent with two turbines. Three different basic configurations for windmills are referred to. Two optional configurations described use a smaller diameter turbine joined to the drive shaft. However, the prototype had the larger turbine joined to the reverse rotating cage 6, with the load being applied to the body 5 instead, using alternative optional configuration described by the patent draftsman. This demonstrated the simulation to a "pulley" action very effectively. The turbines instead would have the pitches of their respective blades arranged so that with wind driving both turbines, the turbines would rotate in the same direction as each other. By allowing the higher ratio input rotational force to develop inertia and momentum, between itself and the reversing cage, this larger turbine was able to absorb this energy, having little effective load on it. The building up of inertia so that at some later time, when the wind was at a chosen level, the suitably designed turbine blade would be forced, by increasing wind pressure, to slow the cage's backwards rotation, which would apply torque to the load connected to the

body 5. This would result in the two input rotational forces and rotational speeds to add together resulting in the body 5 rotating at a greater speed than either of the input forces. This development was videoed for further analysis, however only two contra-rotating turbine blades were available at the time which demonstrated some features. The third
 5 option described was accelerating a cam providing a high ratio output using two contra-rotating propeller blades.

Fig 2 The above planetary mechanism was also installed in a VW car. It was coupled onto the existing gearbox in a very preliminary test, using a 2 h.p. electric motor powered by an AC lead which allowed the slow movement of the car in 1st gear. An eddy current clutch
 10 was used employing 24 volt batteries. This was to simply demonstrate the possible relative sizes and practicality of using the roller gear. I had difficulty in getting any assistance to produce any of the greater features described in the following pages also because it had to be developed secretly, with confidential agreements, so I only told very few people how it actually worked.

15 In order to develop an accelerated high ratio component for similar use, (called planet wheel 28 as shown in the French Patent PCT 74784/91 and others. Also see PP above page 14 and page 1E etc) a smaller transmission was installed in a mini-bike accelerating a cam using 4 scallops and three rollers, in a hybrid configuration. This was a way to test the various ratios and it was successful. An optional practical design was described by a Micro-Electronics
 20 Engineer for use with a fuel cell, on Pages 28 and 34. However, this design is further able to be enormously advanced with the added and alternative high torque configurations described in this patent.

There is the ability to have extremely sophisticated electronics and advanced micro-controllers at very low cost with this invention, due to the self controlling nature of the
 25 design.

Suitable cages (i.e. planet carriers) of any type of planetary gearing can optionally be used as described in the patent, in many drawings there have been more cages drawn to indicate the option. FIG 5, 12, 29A, 30, and other body leaning requirements also require low ratio options such as four wheel steering, or robotics as described in this patent.

30 Fig 3 Shows just some of the multiple various abilities of this transmission described throughout the patent. There are numerous options particularly accessing almost any rotational requirements. These can all be accessed on one side or both sides of the motor or double or multiple motors. Optionally, No 1 generators, and No 2 accelerators can further be motors or generators, they can be interactive in any method, as required. Many types of

control options are available as described in the pages of this patent and the Provisional patents. Many types of clutches are further described No 3 any type of No 4 fluid or hydraulic or molecular control is also available or any type of brake No 5. Balancing is also described and optional multiple cams are shown No 6. Further contra-rotation is another option. The contra-rotation features of these transmissions are all similarly available on one or both sides. Parts of the gear may be integrally manufactured with the hub of the wheels or impeller blades. Optionally either side or both sides can be variable speeds as described, for example in page 2 and other pages of the patent. There are many other transmission systems described. Some of the ratios shown here can be, 2:1, 3:1, 1:1, 4:1, -1 to +1. These are able to be varied and chosen to suit requirements by calculation, the low ratios described can further have the ability to optionally provide a relative high ratio to the centre shaft. For example, three scallops and four rollers having the 4:1 high ratio could be used for any requirement, for instance this can be the method described in the Provisional Patent pages 12, 14, 15, 1E to accelerate a cam or high ratio component for the various reasons described

Fig 4 The easiest way to understand the main feature is by reference to French Patent 74784/91 in which they have to use two planetary bodies to accelerate their planet wheel 28, whereas this invention has the ability to have a far superior action which is provided by the reverse rotating cage 6 which can provide an accelerated cam (or planet wheel or similar). with multiple cams as an option. Many different further advantages are described as follows.

The transmission is based on a very simple action. It can optionally use any type of suitable design of planetary gears, or any reverse cage pumping action, providing feedback from a load. The reverse, or pumping, feedback cage D6 will continue to go backward until the rotation speed of the shaft and body are up to a 1 to 1 ratio. Refer to page 2 of both my provisional applications above in which some examples are mentioned. Also this Patent No. AU-A-93246/98, pages 66 to 72 (or 39 to 43) See "Wheels Within Wheels" 1996, where I described revolutionary transmissions, including any suitable internal pumping for speed control. Hydrostatic balancing can be combined, for example, by pumping or using even the lubrication in order to reduce or eliminate "metal to metal" contact with any chosen material such as by appropriate grooving in and around the rollers and other relative surfaces requiring machining for long life. Optionally, an internal vane pump can be used between see Fig 6 A, could provide internal speed control and governing, by coupling up the high ratio cam/component to the body. The pumping can provide cooling, and filtering. The

ability to combine many types of regeneration and return of energy can be provided internally or externally such as already described. Accumulation for gas, hydraulics, high efficiency batteries, capacitors, are very compatible and energy can be stored in, for example bicycle, and motorcycle frames, tanks, or anywhere for return at a required time. High efficiency batteries may even be carried by the user.

This transmission can have enormous hydraulic capabilities with internal or external pumping. There are numerous options shown and described in the provisional patents, Australian Patents and this PCT Patent.

This transmission is further able to provide an interface between power sources and loads and it can further integrate power sources. It can further provide multiple required ratios for inputting, outputting, or mixing rotational energy. It can, for example, provide equal relative inputs (or chosen ratios by calculation) for contra rotational forces and further equal relative outputs (or any chosen ratios) for loads by choosing cage and roller ratios, and, for instance, laminating bodies. Cage/cam combinations can provide very low ratios if needed, with the ability to provide reversal in direction by choosing or changing relative ratios of rollers with scallops, for example to provide multiple ratios or concentric or other requirements.

Page 3 line 25 of both provisional patents state "In another form of the invention, a planetary gear having a variable balancing mechanism between any of the main three components of the gear, which will allow for combining one or more rotational angular velocity, so that rotation of any said component will likewise cause rotation in the other components providing one or more angular velocity output also with the choice of contra-rotation."

Further, these three components of Fig 1 could be duplicated and interchanged, coupled together, as shown in various drawings in my Australian Patent. It could provide low and high ratios with multiple outputs and/or inputs, or concentrically and for example, to accelerate a cam. This is shown in Fig 4 of both my Provisional Patents 14-11-97 and 18-9-98 and also described on page 14. Also page 1E from line 12, also in Fig 6 of the Australian Patent No. AU-A93246/98. This high ratio cam is wonderfully available with everything else on the same axis. In many other patents similar types of planet wheel operations may be used with flywheels and starter/generators or similar, as for regeneration. This high ratio action is pancaked here and integrally being driven by a combination reverse rotating planetary cage within a body having two sets of rollers. This is a revolutionary and an

extremely advanced method of not only providing the same advantages provided in the French Patent 74784/91, with what is referred to as the planet wheel 28 of the toothed gearing in Figs 3 and Fig 5. It is further doing away with their need to have two separate planetary gear bodies (see my Provisional Patent PP 6043 page line 5 to 20, also see my
 5 ~~above~~ Australian Patent Pages 66-72, WWW and particularly items 6 and 12, also see Fig 4A and 6 A in this patent). Further, amazingly, this high ratio integral secondary planetary component is achieved on the same axis in a single body. This can possibly extend the "Pulley" action even further, because of the automatic self regulation. This self regulation, is achievable in numerous, self controlling, centrifugal or governor type operations, because
 10 the rotation speed of the body is relative to the load.

Many types of speed controls are now possible, for example, by using various centrifugal and/or governor actions. For example, it can be controlled between the "No. 1 Inner Cam", and the high ratio accelerating cam, (planet wheel,) or component of any type, and the now free to roll body.

15 Fig 4 As well as the enormous advantages described by using this integral high ratio component, some optional methods of integrating rotational forces are indicated. There are options for many different ways of controlling this transmission, or accessing other added differential actions available. For example, there are configurations available for using the reversing double cage, or the body for combining or inputting one or more rotational force.

20 These forces may or may not be developed on the same axis. However, this transmission allows them to be mechanically "processed" within the same axis. Various options of clutching in order to combine rotational forces onto the high ratio shaft and/or the double cage shaft may be combined, using one way clutches or any other types of clutching are described in this patent,

25 Sophisticated micro-controller control can be simply employed due to the simple nature of this transmission. See Fig 6 A descriptions below and others. Many combined dynamic and reactive options are possible.

One load lifting test conducted on a lathe which has been witnessed, shows that only approximately 1.5 kilos on the high ratio cam was required to lift approximately an 11 kilo
 30 load on the body. Both the loads were on 35mm diameter shafts and the rotation speed was 30 RPM at this time. (Some of this similar testing has been witnessed and videoed). When the double cage was tested, due to the freewheeling nature of it accelerating the cam, it varied and was inconsistent, it required well over 7 kilos. The single forward rotating cage

on the other side was 35mm diameter and was not tested in this demonstration. There is already a video available of a similar transmission in a small hybrid four wheel mobile which is shown driven either with an independent battery, with forward and reverse power, or combined with a petrol motor which when started, uses the regenerated electric power to add to its power.

Fig 6 A and 4A. However, by allowing the body to roll, the invention provides the ability to incorporate possibly other further resemblances to "pulley extensions". By further adding a forward rotating cage to this transmission the output can optionally now be extended by the chosen ratio cage. This is benefited by the relative internal contra-rotation of these two cages, together with the ability to wonderfully still enclose the transmission. Any centrifugal control may be more effective. Further, optionally, relative ratios can be chosen and can be provided by a forward rotating planetary cage in a method to extend the resemblance to a pulley action, which may be calculated to capture torque advantages fed back. However, examples of the roller option could be achieved with the lower relative ratios provided by the ability to laminate bodies and cages, allowing lower ratios. For example, one option combines three bodies laminated with (for example) 3,4,3, scallops each, with a double cage in the center having 3 rollers for reverse rotation, able to accelerate a cam with 4 rollers, and a contra-rotating forward rotating cage of four rollers for the load. An alternative optional combination would have 3,5,3, scallops with 4 rollers for each of the others providing the centre shaft with a 1 to 4 ratio for the double cage which would provide an equal and oppositely rotating high ratio cam of 1 to 1 ratio relative to the centre shaft. Impressive load lifting tests were conducted on lathes for this configuration, as described herein. The high ratio cam can be constructed having one or more cams "advanced" by any degree in order to allow for smoothness and the rollers can be constructed or recessed to allow for any physical passage or each others cam rotation.

The same high ratio cam (or planet wheel) can optionally provide a second input for contra-rotational forces. For example, contra-rotational and frequency controlled motors or any rotational forces, or can be used to couple one or more contra-rotating inputs into the transmission, hybrid or regenerative inputs or independent reverse and forward transmission. Flywheels and braking are able to be used to optionally control these and can, for example, be interchanged between the high ratio cam and the reverse cage as required. See the various configurations in the drawings. For example, for starting mechanical mechanisms for I.C. motors combined with regeneration or any other requirements can, for instance, use

centrifugal action, one way clutches, other latching mechanisms, electro-mechanical, centrifugal, molecular coupling systems or can be manually operated. The option of highly sophisticated yet simple micro-processor control is extremely easy to couple in most instances. Multiple blades could be used in any windmill configuration.

5 Fig 4 As well as all the advanced systems described in this patent with reference to automatic and high torque, linear and hybrid transmissions there has further shown up enormous advancement capabilities to totally revolutionize electric motors. There has been described in this patent many different electric motor designs. Some of these motors were previously impractical, therefore my invention has been in great need.

10 There is the further option of running these motors and contra-rotating input rotational forces at any relative speed continuously. For example, optionally, trains or any other machinery may benefit greatly, however trains could also benefit by using the other high torque and hybrid systems described, for example in fig 6 A, C, D. The power sources may come up to a 1 to 1 or alternatively any chosen ratio for high torque and efficiency.

15 Fig 6 A and Fig 6D. The Transmission shown in Fig 6 A can be totally controlled internally or externally. In one method, internal pumping between the No. 1 inner Cam 3a and the cage D6, by the alternative vane pump 27 providing powerful compact transmissions. Control and governing can be achieved simply as described, by even pumping the lubricating oil and combining centrifugal action and/or control between
20 the high ratio component 3b and the rolling body. There is described many pumping abilities see Pages 66 to 72 such as displacement between rollers and scallops which can provide very simple self regulation by centrifugal action against gravity of even the lubricating oil. Many different methods are able to provide centrifugal governing because the rotation speed of each transmission is related to the source speed and load speed
25 they are coupled to. Ref to pages 32-34. For example Fig 6 A or in Fig 6 D. Further alternatives are shown, as described in this patent, see Fig 26A to have everything rotating internally or externally including the microprocessor, because of the dynamic operation, the load can support the transmission or the transmission can support the load and all the rotational forces can be integrated. Only the necessary couplings for support to the frame
30 are needed which can be anywhere such as shaft bearings with any necessary ground references and for braking and one way clutching or external needs for coupling between rotational forces. Multiple concentric outputs can further be achieved using cage/cams driving one into the other. The ability to change direction can be achieved, for example, using cage cams with one reverse rotating cage/cam driving another reverse rotating cage or

cage/cam providing forward rotation, then if required another with more rollers than scallops can be employed to provide forward required ratios by calculation.

Optionally the high ratio cam shaft can be concentrically inside or outside the double cage. For example (see Fig 6, A or Fig 6 C).

5 There are many options for accessing every variable need, one example of one design I described is as follows- (This has been described in the patents as resulting from my consultation with another motor manufacturer, see pages 22, 23, 24.) Two motors with two separate frequencies and required phasing, may be used onto the input shaft and the high ratio component. Two sets of coils and "Heterodyning effect" can be incorporated.
10 Energy transfer between the two parts, i.e. two frequencies in phase or the amount out of phase can be designed to maximize energy transfer. Further, a third (or more) input rotational force is described and shown in the drawings. This can further incorporate regeneration. The resemblance to a "Pulley effect" can be perhaps extended.

As mentioned, highly efficient contra-rotating electric motors have been offered by one
15 University, and also from a magnet manufacturer, the use of which was described in my Provisional Patent of Refer to the two Provisional Patents above named "Variable Ratio Multi Gear" 14-11-97 and 18-9-98, which state from page 2 line 23, to line 28:

Although planetary gears are known, the prior art gears have failed to take advantage of
20 certain of their features, in particular, the contra-rotational nature of the input and output shafts being on the same axis. Planetary gears can provide features such as an operation similar to that of a transistor, where huge amounts of power may be controlled by a small amount of controlling power, there is also a torque doubling effect, refer page 36, line 24, plus many other following benefits.

Sophisticated techniques involving integrating, balancing of heterodyning more than one
25 rotational force, are applied either internally or externally to this device.

Super heterodyning. However my following Provisional Patent of 18-9-98, is describing the optional advancement of "super heterodyning", (refer page 1E of this provisional) This could further benefit many of the previous invention options.

Provisional Patent 18-9-98 Page 1E.

30 This invention relates to improvements in mechanical gearing, providing a rotational motion conversion apparatus for converting any rotational force or forces to more easily produce maximum optimum torque at any desired RPM, whilst accessing these several internal planetary drive advantages repeatedly. The present invention provides a means of mixing

say one or more rotational forces and also combining them with an existing rotational force, so that resultant multiple rotational forces are all rotating at required RPM's, in order to sum the two RPM's or subtract the two RPM's so that they will provide significant increases in the systems matching capacity, whether it is required as a fixed, variable, or linear ratio drive.

In one form of the invention, there is an option for any or all of the three basic components of the planetary gear to support electro-magnetically controlled components in order to provide the heterodyning requirement, however, there is the added complementary ability to pancake our gear with or without an integral second planetary component as shown in drawing Fig 4, which could capture multiples of extra contra-rotational torque described herewith, plus also providing interface abilities for combining any required or programmed performance from "Hybrid" type inputs, whilst providing a specially programmed RPMLO as well. For normal city type driving, the yo-yo action (first described in my expired 1995 Provisional Patent application) could, for example, dramatically increase reactive repetitive energy from "Odyssey brand type" batteries which will accept huge boosted charge when slowing, braking or clutching, ready to instantly return huge boosted added power when called on to accelerate. There is also the ability for one rotating component of the planetary drive to support say, a planetary cage, a set of coils, a set of magnets and a cam for the next stage, or say an outer body with a set of coils, a set of magnets, and with a planetary cage combined for the next stage of rollers. (FIG 5 - 7.)

When described and shown my contra-rotational input description using one of the optional method for "super heterodyning electronics", one Technical instructor agreed with my suggestions comparing it by first drawing the "Servo" system used in a video tape recorder, which has two stable clock "reference" frequencies and two comparators sensing the phasing and frequency which operate as a "Master" control when these PG and FG are mixed together providing error correction for the drum motor as the "Slave". He further drew my two motors (which are on the same axis) side by side with one being the Master and the other being the Slave. He described it as reversing the role of the two motors Slave and the Master repeatedly, providing a "Variable Reference", with the adding or subtracting of this, likening it to "super-heterodyning". He further drew a micro-processor with inputs and two outputs, with the micro-processor choosing the required corrections and outputting them to either motor for a pre-programmed error correction, or corrections for any other scenario. There could be sensors on the inputs, sensing for example, RPM, peak torque

detection, and/or also any type of inclinometer sensing or sensing of the temperature at i.e. IC Motor exhaust ports etc.

Patent pages 22 line 11 to 24 line 6, are describing another motor manufacturers various, optional designs. Super-heterodyning can optionally be applied to any other planetary options as is further shown in Fig 5, Fig 6 & Fig 7 of the 18-9-98 Provisional patent, page 1E. Fig 5 is also showing the roller gear equivalent to the French Patent 74784/91, showing that it is possible to optionally provide forward rotating cages in the same way as toothed gearing, (if chosen) using one more roller than scallop, in order to duplicate the actions of this Fig 5 toothed gearing of the French Patent. However, Fig 4 shows there is now the enormous ability to do away with the separate bodies and use the common body capturing multiples of contra-rotational torque with the integral high ratio component.

With the roller gear high or low speed rotation and balancing can be achieved by choosing, for example, suitable offsets for the cams, and/or multiple configurations. Such as one or more cams with advanced rotation, with suitable recesses or steps in the rollers to allow for the relative passage of the balancing rollers requiring to pass each other. Balancing can be incorporated throughout, internally or externally. Various configurations and ratios can be combined, plus the use of, for example, needle roller bearings to achieve compactness and smooth operation.

By combining cages with cams, cams with cams, cages with cages, or choosing required numbers of scallops relative to rollers, or laminating bodies, I could achieve any ratios together with the further ability for many concentric options. Please note: The Roller gearing option can provide a great variety of ratio combinations. Some of the drawings show many more cages than needed, which indicate that there could optionally be used common forward rotating toothed planetary gearing. Small plastic examples of these common multiple gear sets are available from "Hobby Shops". This transmission can further provide extremely low ratios or multiples of different ratios from any number of optionally configurations, these can be concentric or not, as shown in many of the drawings. Or there is further the option of numerous alternative configurations to be designed and I have only tested a few. There are an enormous number of variations available by calculation providing ratios or configurations for better operating of many applications some of which I have described in the Australian Patent "Wheels Within Wheels" pages 66 to 72. See Fig 6, C There is the option of using rollers with axles. For example, the rollers could be interposed between interconnected plates. The plates could have elongated slots for

sliding the roller axles in. The option of concentric operation is there as well as optionally having the high ratio input/output on the inside or the outside of the reversing cage.

As mentioned, this is a method of achieving third dimensional feedback for controlling loads particularly on one axis. The wheels in Arthur's patent were partly performing the action of feedback from an external axis and being controlled on an internal axis. My two wheel drive option can further extend and enhance my resemblance of a "pulley" system. This can provide revolutionary third dimensional control from one wheel to the other, together with optionally providing other reactive automatic systems for two wheels (or more) relating to each other with the road providing the third dimensional reactive feedback for reference.

Refer to items No. 16, 19, 20, 30 etc, WWW.

If required this common axis can be supported on one common shaft, and further a common rotational input rotational power source or sources can power two outputs, or, for example, can support both wheels.

The drawings in this present invention are showing just a few of the multiple applications, showing mechanical transmissions accessing three-dimensional feedback, working in complimentary relationship so as to feed back and automatically control and/or make reactive corrections, (which resembles extended "pulley" systems. Amazingly all these features can now be provided on the same axis. Further, the load can optionally be taken from the body of the gear as in Fig 2, Fig 4, and others, or taken from the cage/s, or from the cam/s. It can have multiple takeoffs and can have multiple inputs.

This transmission can provide integration for the maximisation and transfer of rotational power being the means for providing powerful high torque and linear or universal and/or interactive transmissions. Refer also to the Australian Patent AU A 93246/98 showing further optional methods. Many advanced applications are shown in the "Wheels Within Wheels" pages of 1996. (Pages 66 to 72 in this Australian Patent.)

Note - page 3 of both provisional patents PP0404 14-11-97 and also PP6043 18 9 98. One object of this invention is to provide a device which is able to provide a continuously variable output angular velocity to input angular velocity ratio. Another object is to provide a device which is able to combine more than one input angular velocity or, alternatively to also optionally provide one or more angular velocity output. To achieve this, sophisticated techniques involving integrating, balancing or heterodyning more than one rotational force are applied either internally or externally to this device.

Another object is for a device to provide or contain a type of biasing, ramping up or fast

acting rotational energy storage mechanism allowing for optimum torque to be gained when stepping through discreet gear systems.

Page 2, last sentence of the Patent and PCT states: "In a second embodiment, a planetary gear has a variable balancing mechanism between any of the main three components of the gear which will allow for combining one or more rotational angular velocity, with or without the use of a variable brake so that rotation of any said component will likewise cause rotation in at least one or the other components, providing one or more angular velocity output also with the choice of contra-rotation."

The total transmission can be allowed to float, producing revolutionary types of combined extensions to the "Pulley" system.

optionally they can be part of the wheel and/or built into the wheel which may be the load itself.

Fig 6 in this Australian Patent 93246/98 shows two basic alternative designs of this transmission, it shows a double (compound, left and right side) configuration with these two combined options. The left side firstly shows the option of the high torque and high ratio cam. The left side also correlates and depicts what can be the operation of Fig 4A in the provisional patents and patents, if required. It can further be represented in 4A in fig 6D.

The second optional configuration (SHOWN IN BRACKETS, as INNER CAGE WITH CAM Fig 6B) is a universal optional configuration which can have any chosen cage/cams turning in any chosen direction which can be used for forward, reverse or changing direction, by having more or less rollers than relative scallops. More cages can be used concentrically placed as required, it further shows also the ability to have multiple concentric lower ratio inputs or outputs. Fig 6 in this above patent also establishes many other drawings also showing both the optional internal configurations. It

shows how the No 1 inner cam is the essential component in this transmission, clamped to the shaft. In the double sided configurations, requiring a second cam, it can be and is drawn as one cam in many of the drawings. This cam can optionally be operating both cages on left and right sides together if chosen, or it can be separated by any thing, for many of the different options possible. For example, this could allow the left and right side to be totally

independent and separate and if required, rotating separately.

The unique ability to have No 1 Inner Cam 3a providing the reverse rotating cage D6 by having one less roller than scallop, allows for the high ratio component or cam. Any normal forward rotating planetary action or gear can alternatively be combined and used (internally

or externally). This planetary action would be driven, for example, or coupled to the reversing component and may achieve the same high ratio requirements in any chosen way. There are many options as to where the high ratio cam or component is placed and it can operate in any way. Any chosen planetary designs may optionally be used in order to achieve this action. Normally these designs cannot achieve this action within the common body such as item 28 of the French Patent 74748/91. Therefore there is a great advancement here with the ability to combine centrifugal advantages and control. The high ratio component could have the necessary chosen toothed or any other required components in order to actuate it. Fig 6A, Fig 6 C and Fig 6 D can further clarify very important rotation and contra-rotating actions by the various combinations of planetary parts, also describing how many of the other drawings operate. For example the "No 1 inner cam" and the "No 2 inner cams" can be joined together, a spacer could be placed between them if required, allowing different rotation or contra-rotation of the cages. The two halves left and right side could be self contained and separated if required. Pumping action can be used optionally internally or externally, for example, see vane pump 27 on the reversing cage as is shown in Fig 6 A. The pumping action can work similarly to other variable speed transmission such as the Mitsubishi operation described below, however now with the enormous advantages described as being able to centrifugally control the pressure between the high ratio component, against the free to roll body providing extremely simple transmissions.

By holding the body of one prototype transmission in one hand and turning the shaft with the other, it can simply demonstrate how the contra-rotating cage inside would only need some form of internal loading, on its reverse rotating cage or "centrifugal control governing" in order to bring any load up to a 1 to 1 ratio, because it will continue to go backward until this occurs. By further adding the optional high ratio component and holding the optional cage output, (one or more if toothed gears are chosen, allowing the body to float, it can demonstrate the enormous third dimensional operation of this transmission extending a likeness to a "pulley" system.

This "Number 1. inner cam" by combining optionally a high ratio output within a double cage drives the high ratio cam/component using similar principles as for example the French patent 74784/ 91 PCT/FR91/0015. There is further the ability to duplicate other possible "pulley" type transmissions on one axis, such as the "Mitsubishi design" EP 0 794 360 A1, provided by the international type search which was done by the patent office shown as

- being relevant, but amazingly this is now achieved internally and on the same axis. (Also see PCT/FR89/00231) The output can now be taken from the outer body enclosing everything, operating the same as the French patent as well. For example, a pair of centrifugal clutches or a torque converter. The "pulley" extension can operate further by accelerating some form of controllable loading, or similar energy storing mechanism such as a flywheel, or a pump can be providing pressure, for example, to control a high ratio vane rotor providing automatic high torque transmissions. There can be hybrid or added input feedback, regeneration, input from another rotational force, providing, optionally, integration and independent reverse and forward power which can be input alternatively between the feedback double cage and the high ratio component. However, further relative ratios can be included (by the No 2 inner cam). Toothed gearing cage or cages may be chosen and is depicted in many of the drawings showing many cages. The last cage providing the output instead, for example, by allowing the body to revolve freely. Low ratio options Refer Fig 6 in the Australian Patent No. AU-A-93246/98 Also see Fig 6B. This ability to go in either direction is further enhanced by the ability to be cascaded, laminated, provide multiple ratios concentrically and from either side or both sides if chosen so as to combine any chosen low ratios by calculation. There is the ability to change direction concentrically as well by for example. By providing one reverse rotating cage/cam driving another reverse rotating cage cam which will now turn in the forward direction, if continued, the next cage cam could continue the forward reduction ratio if chosen, if it has more rollers than scallops.) However the above drawing shows any optional two cage cam option, "showing in brackets" "inner cage with cam") on the left side. The right side shows a cut away option, one or more forward or backward rotating cages can be used. Multiple combinations are available by various configurations.
- FOR FANS, HELICOPTERS, AIRCRAFT OR SIMILAR:
- * Added to the 2.5 to 3 times more efficiency described above using two motors, Woods published information further suggest additional stages can further be added which would also be extremely complimentary to the already enormous above mentioned advantages described above.
 - * The further ability to manufacture contra-rotating fans or any propellers, able to be supported from one end only, is an enormous advantage.
 - * Most noise is created by wing tip speed and this is substantially reduced. because of the built-in reduction ratio.

* By having two cages of the formula 5 and 3 within scallops 6 and 4 this will allow holding the 5 roller cage stationary for one end propulsion (providing equal contra-rotation) together with the added controlling abilities see pages herein. Optional formulas (or multiples of either), is with an 8 scallop body/ring coupled to a 5 scallop body/ring with a 7 roller cage held and a 4 roller cage providing equal contra-rotation with the body.

- * Smaller diameters would result and could be a small fraction of the weight.
- * Able to accept low cost 2 or 4 pole motors instead of 8 pole motors often used in commercial installations.
- * Only one low cost power circuit and control required.
- * Wouldn't need the structural support or the high cost of cranes needed to install many of the present large ones.

All other requirements such as aircraft, helicopter, hovercraft and any similar requirement should similarly be able to benefit.

This transmission has been described by engineers as being totally revolutionary and can further provide hybrid systems which can totally be on one axis, which means that all the power sources, whether Internal combustion, Electric, Digital stepper motors, or any rotational power which also can be heterodyning in any manner, can be on the same axis as the planetary system, which can include Accumulators, Flywheels, Oil reservoir, Regeneration storage, Surge absorbers, Electronic Interfaces, Pressure flow valves, Micro-processor/CPU. These as well as the drive can be on the same axis.

THREE DIMENSIONAL REACTIVE FEEDBACK, FROM LOADS FOR THE LINEAR CONTROL AND MANIPULATION OF MECHANICAL DEVICES, AND/OR PROVIDING HIGHLY EFFICIENT AND COMPACT TRANSMISSIONS AND/OR HYBRID DRIVES. See "Wheels Within Wheels" 6-6-96. in my Australian Patent above or see my claims.

Radio receivers use an extremely clever and effective automatic gain controlling method to achieve linear volume from weak or strong signals, by taking a feedback voltage from the output and inversely applying it to the input. I have been searching for years for some direct mechanical means of using the same technique for automatically controlling mechanical loads using a similar third dimensional feedback. Extremely low ratios are possible with this fixed ratio planetary gear providing also large diameter multiple inputs and outputs. This makes it possible to have extremely compact transmissions, sometimes only needing one cage, however there is the option of having multiple cages with concentric capabilities. Together with the unique reverse rotating ability of the cages makes viable many different

features and configurations which are available amazingly on one axis. This gearing is extremely versatile with being able to change direction of the rotation by having different relative numbers of rollers to scallops.

5 The added uniqueness is that in the roller gear option shown, is that only the first cage (or optionally the high ratio component) needs to feedback, to control, or be controlled. It may be chosen, for example, to generate current, for the charging of any type of storage or regenerative means, or it may use eddy currents and/or actually motor itself. Enormous high torque is available in many different methods described with the added second integral component described in the Australian patent and also in pages 66 to 72 "Wheels Within
10 Wheels" items 3, 6, 12 of the provisional patent page 1 E. All these relative inputs can be mechanically or electronically controlled, or with perhaps, centrifugal means, or liquid polymers or similar, see patent. This feedback cage shown can also be used with either similar power sources, or to integrate multiple rotational forces and hybrid inputs, allowing for any type of engine/s, or motor/s. Combined starting of IC engines can be combined.
15 This gear feedback method is very complimentary to the latest fuel cell technology, with the added ability to choose the positioning and types of input power/s or regeneration forces chosen for each individual situation by referring to the simulation option shown in Fig 9. This program can be a means of rapidly choosing controlling methods for any number of input source/s, in order to maximise linear output, either for initial design, or for any
20 continual operation.

The feedback cage or high ratio cam/component can further provide simple convenient optional inputs. Optionally these cage/cams can motor within themselves, and also provide reverse and forward gears and brakes are able to also be achieved on these feedback cage or high ratio cam/components, and input shafts. There can be relatively large shaft diameters if
25 needed, due to the coaxial nature of this optional design.

Fig 26A refers to combined power sources and transmissions (Fig 24A below also refers to many variations possible). There are many ways to couple the power sources, either internally or externally. There can be many ways of controlling this transmission as in Fig 6 A (or left side can be as in Fig 4 A, options) Highly effective hydraulic coupling and
30 control is further available. Enormous power may be controlled from one axis. One of many Hybrid transmission configuration options is described by an engineer below. This can be further controlled by many different methods, one hydraulic method could be with the primary input to the input cam and also driving a small second hydraulic pump which

could be controlling a second pump/motor which could control the reverse rotating high ratio component. There could be a hydraulic circuit through a proportional control valve, motor and motor/pump combination accessing a common oil tank, this optional control system is briefly described below as being one of 1 to V options. Optional additional power sources can be combined. The components numbered can be, for example as follows:

1. Fig 6 A/4A, 2. Power Source, 3. Microprocessor (can be internal or external, at dotted lines).
4. Pressure/flow electronic interface valve and flow sensor, 5. Regenerative storage and surge absorber valve control block with electronic interface. 6. Revolution Counter Sensor, 6A. Direction Sensor, 7. Pressor Sensor, 8. Oil Reservoir, 9. Flywheel Disc Brake, 10, 10
- Throttle Interface Diesel, Petrol, Gas, etc., 11. Electric Motor Interface 1 to 3 phase, 12. Digital Stepper Motor. Control Interface, 13. Drive, 14A, 14C and 14E are optional coupling points for external electric, mechanical, hydraulic, pneumatic, etc, control. Also heterodyning of RPM sources. Alternatively concentric inputs. Optionally can be contra-rotating inputs. 14A, 14C and 14E are optional coupling points and possible flywheel and brake positions (depending on requirement). 14C Option coupling point as additional and optional added power source can access some of the many added abilities in this patent and can control various configurations in stationary situations. With optional flywheel brake and sensors 6 and 6A. 16 Accumulator. 14A, 14B, 14C, 14E, are all possible coupling points with flywheel possible. (The above optional control 1 to V is not shown here.)
- 20 As (14a) receives an input from the Primary Engine, the cam starts turning in one direction. The rollers which are located in the cage will now force the cage into the opposite direction (14c), as a load is coupled to (14b). Coupling (14c) drives a hydraulic rotary device (Pump/Motor) number 2 which receives its oil from a oil reservoir number 8. This oil is pumped into a normally open proportional control relief or flow control valve number 4. On
- 25 the input shaft (14a) there is also a hydraulic rotary device, a pump number 1, connected which also receives its oil from oil reservoir number 6. This oil is pumped into the proportional control relief or flow control valve 4, which is normally open. The oil flow from pump 1 and 2 return to the oil reservoir via a normally open proportional valve number 4. This valve is being controlled by a variable D.C. voltage control card or ramp card.
- 30 [Controlled, (acceleration over time, can be a CPU)]. When the load movement signal is selected, the proportional valve number 4 receives a proportional voltage signal from the CPU. This will create pressure (psi) in proportion to the voltage signal. Pump number 1 and 2 start building up pressure. Pump number 2 will start to slow down in its rpm and the

1. FIG 6 A/4A, 2. POWER SOURCE, 3. MICROPROCESSOR, 4. PRESSURE/FLOW ELECTRONIC INTERFACE VALVE AND FLOW SENSOR, 5. REGENERATIVE STORAGE AND SURGE ABSORBER VALVE CONTROL BLOCK WITH ELECTRONIC INTERFACE, 6. REVOLUTION COUNTER SENSOR, 6A. DIRECTION SENSOR, 7. PRESSOR SENSOR, 8. OIL RESERVOIR, 9. FLYWHEEL DISC BRAKE, 10, 10 THROTTLE INTERFACE DIESEL, PETROL, GAS, ETC., 11. ELECTRIC MOTOR INTERFACE 1 TO 3 PHASE, 12. DIGITAL STEPPER MOTOR. CONTROL INTERFACE, 13. DRIVE, 14A, 14C AND 14E ARE OPTIONAL COUPLING POINTS FOR EXTERNAL ELECTRIC, MECHANICAL, HYDRAULIC, PNEUMATIC, ETC, CONTROL. ALSO HETERODYNING OF RPM SOURCES. ALTERNATIVELY CONCENTRIC INPUTS. OPTIONALLY CAN BE CONTRA-ROTATING INPUTS. 14A, 14C AND 14E ARE OPTIONAL COUPLING POINTS AND POSSIBLE FLYWHEEL AND BRAKE POSITIONS (DEPENDING ON REQUIREMENT). 14C OPTION COUPLING POINT AS ADDITIONAL AND OPTIONAL ADDED POWER SOURCE CAN ACCESS SOME OF THE MANY ADDED ABILITIES IN THIS PATENT AND CAN CONTROL VARIOUS CONFIGURATIONS IN STATIONARY SITUATIONS. WITH OPTIONAL FLYWHEEL BRAKE AND SENSORS 6 AND 6A. 16 ACCUMULATOR. 14A, 14B, 14C, 14E, ARE ALL POSSIBLE COUPLING POINTS WITH FLYWHEEL POSSIBLE. (THE ABOVE OPTIONAL CONTROL 1 TO V IS NOT SHOWN HERE.)

load will move in proportion to the rpm of this pump (pump number 2). As valve number 4 is receiving more voltage and consequently producing more flow restriction and pressure buildup on pump number 2, the ramping or acceleration of the load continues to a point where pump number 2 stalls and can no longer deliver oil as a pump. Pump number 1 is still delivering oil and this oil is now forcing pump number 2 into the opposite rotation. This pump has now become a hydraulic motor (number 2) and turns the cage in the same direction as the scallop ring (body). This oil coming out of motor number 2 is now delivered back to tank via the previous suction port when it was a pump but now is a hydraulic motor. This control design can be constructed in many different layouts as indicated in drawing I – IV. An optional design can be achieved by driving pump number 1 by a variable secondary input engine as per drawing number V. The control principle of the cage rollers is the same, but the secondary variable input engine would add its power to the primary engine or motors. The objective of the cage control is achieved by forcing the cage into stationary mode and then into the opposite direction of rotation. This is accomplished by opposite oil control flow of pump/motor number 2, by means of pump number 1 and proportional oil control flow valve number 4. Also note that a hydraulic rotary device can be a pump or a motor simultaneously depending on how the oil flow or the physical rotation is applied. As a bonus, the cages in this gear are able to contra-rotate on one axis providing higher efficiency electric motors. This can combine multiple gears in this type of configuration, perhaps for heterodyning the power source/s 2 and also for between 1 and 2. Refer page 32 Australian Patent, there can be combined hydraulics options, (as also 26A above,) all on one axis there may be multiple gears performing in line, with sections taken for pumping and others for electric motor rotors.

See also for fluid passing equipment, see Woods published figures, see patent.

The entire multiple machine incorporating engines, motors, pumps, rotary combustion engines, hybrids, can be all on the same axis if chosen, separately or jointly rotating where chosen, together with the necessary regeneration requirements such as flywheels, capacitors, batteries, accumulators, and microprocessors, as mentioned in the patent. The ability to further control everything using brushless commutation or wireless remote control is optional.

The drawings Flg 1 to 30.

Fig 7 At lower ratios another patentable method is as follows: By fitting a reference cage to any suitable planetary gear, so as to be able to use the inverse feedback from the load, such

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dimensional feedback and control. The ability to combine any type of reactive and/or third dimensional feedback by allowing the body or any component to be designed to access this either for stationary or dynamic requirements. Even coil springs may be used in some requirements in any chosen method, to access extended ranges or feedback options.

5 The added ability to integrate this transmission with regeneration and hybrid features is absolutely ground breaking, where independent operation of each rotational force is optional or the rotational forces can be added together with the added ability to provide enormous boosted energy which can be returned repeatedly, where required. Many types of regeneration have been described.

10 There is further the option of more simple transmissions in any of the many options described, for example coil springs and/or flywheels coupled to the high ratio component. Coil springs could be accessing any other forms of differential or rotational leverage from any chosen components or coupling points, to provide any third dimensional reaction, for example coupling around the body or relative body movements, cage movements or cam
15 movements, in any way, as required. This could possibly further extend the resemblance to a "pulley" system. Springs could be used to give a load a kick off or similar torque advantages.

Further the ability to optionally couple or transfer power source input rotational couplings alternatively between the high ratio component (cam) to the double cage is described, and
20 can provide for example, starting of I.C. motors, or independent reverse and forward gears. A variety of coupling methods such as clutches, one way clutches, coil springs governors, torque converters of any type, molecular coupling or any electronic means. Hydraulic control and coupling is very complimentary to this transmission with a vast number of options as noted in Fig 24 and others descriptions, of my Provisional Patents, Australian
25 Patent and this PCT.

The option of highly sophisticated electronics which can be coupled in very low cost methods using for example Micro-controllers, PIC or other programming methods are complimentary, some requiring a minimum of sensing inputs due to the automatic feedback nature of this transmission.

30 There have been many methods described for accessing the high torque options, various combinations are shown in the drawings. The Hybrid input or rotational force/s, (such as motor generator) can be applied onto the high ratio component or double cage feedback shown. There are many ways of internally controlling or combining internal with external

control, for example using pumping operations. This invention provides the greatest breakthrough for Hybrid transmissions which can now be put totally on one axis see figures Fig 6D, 24, 26A, 28B. Even a simple internal vane pump could be used as described above for controlling the high ratio component which could be designed for using various methods of governing or speed control to couple it to the body, lubrication, cooling and filtering can be combined. Any type of suitable similar common pump may be used, such as Rotorola types.

Fig 9 Shows a typical simulation diagram for both designing methods for maximising the output from rotational input force/s, and also ongoing correction to maximising the methods chosen. Or further combining two or more rotational power sources through the gear, using variable source/s for correction in order to maximise and extend maximum linear (or high torque) acceleration from equal and/ or unequal forces. Several highly advanced contra-rotating motors have been described in this patent which can be extremely successful due to the interfacing abilities of this transmission. This enabling equal or required contra-rotation ratios for any chosen requirement to be achieved automatically or by calculation.

This simulation diagram can further be applied to two equal rotational forces, or any of the other simple and advanced systems described in the patent. It can further also be used for evaluating and accessing the power from other sources such as stored energy and regeneration described in page 1D, 2, 3, 13, 14, 15 21 etc. of Provisional Patent from 14-11-97, also Provisional of 18-9-98 and Patent 25-5-99, page 2, 4, 13,14, 15, 21,23, etc.

FIG 11 Shows some alternative methods for controlling this transmission, for example the ability to achieve variable control on the contra-rotating propeller type of requirement as shown in Fig 18, for example. The ratios may be as described in fig 7 in order to equally contra-rotate. However total control can further be made available on this transmission if required by the optional splitting of the body as in Fig 11 so as to add any type of clutching or control from between the 6 scallop part of the body and also being able to control the 5 roller cage as shown, allowing the 4 scallop part of the body to support one part of the load while the 3 roller cage is allowed to support the other load. This system can likewise be applied to any similar requirements. All the other advantages described in this patent would be available for smooth operation, such as one or more cams and rollers, built in lubrication and so on. Multiple transmissions in series are very complimentary to this transmission.

Note that most of the drawings are numbered the same as in my Australian patent, which also has in it the correct original Fig 6 drawing, together with the Wheels Within Wheels document in pages 66 to 72.

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Fig 6 is described in page 35 as like looking at the "internal view" of the invention, Fig 12 is looking at the end view of one Fig 6, it is further likened to looking from the "external view" of invention. It is shown with the ability to control and/or support everything mechanically on one axis. There is however the further drawing Fig 30, showing two Fig 6 transmissions in line, one between the front wheels and another between the rear wheels, where the leaning of the body of the car can further provide reactive feedback in order to assist reactive corrections automatically and continuously. Fig 5 may have complimentary operations of any type.

Fig 5 shows the four wheel steering with some amazing options and abilities, however it can further similarly be controlling in methods described, making third dimensional corrections to other chosen reference points, for example correcting caster as well (as described at the bottom of Fig 12).

Fig 5 shows the versatility to produce methods of, for example, a mobile with enormous advantages, such as being able to drive straight, and optionally, turn all wheels into the kerb in order to drop off passengers and goods. Jumbo Jets, for example, could be taxied off runways. There also being the option of providing four wheel steering with the choice of multiple low ratios for back and front wheels or other uses or reactive operations. Additional take offs from the multi-gear can correct castor and camber, refer to Fig 12 for optional integration of very advanced third dimensional feedback which can be further enhanced by incorporating any feedback, or feedback from the rotation of the multi-gear. Refer to Fig 12.

Fig 12 illustrates methods of controlling steering and mobility functions for passengers and load. This can be for four wheel vehicles or more operations or for any type of mobile load correction (even three-wheelers could be designed for leaning into corners). This is seen as a revolutionary step in total transport comfort and safety with enormous variables such as for every form of mobility. Any size of mobile is equally benefited, with the ability to provide totally new concepts. Safety and comfort combined with the optional use of highly efficient and non-polluting drives, if chosen, as above.

Fig 29A The paraplegic person of Fig 29 A shows the ability to provide equipment to correlate and reference positional holding using this inverse feedback. For example, with a paraplegic person in an upright position, the gear can also simulate muscle and ligament movement and touch sensitivity. It is able to be optionally controlled by a gravitational sensor, or similar, which could be at the high point of the spine. Robotics can similarly benefit.

Figs 5, 12, 18, 29A, and 30 illustrates methods of control from reactive and three dimensional feedback as described in patent and also see "Wheels Within Wheels" pages 66 to 72 this Patent and PCT AU99/00452 also pages 44 to 48 PCT 00512 25-6-99. As mentioned previously, gravitational references and gravitational sensors, pendulums, or similar can be used where required, combined with sophisticated electronics such as micro-processors in the best known methods, providing for the power drive and/or over-riding and continuous corrections. Safety and comfort combined with the optional independent use of highly efficient and/or non-polluting drives, if chosen, as above.

Fig 30 shows a typical "body leaning" example which is a car with two multi-gears on the front and rear to control camber/castor etc. The feedback from the leaning over of the car is able to provide reactive corrections so that the car cabin effectively leans into the corner together with the wheels which are able to have camber/castor correction actuated automatically with the ability to provide the drive or fine tune further corrections. All types of transport can be similarly benefited.

Fig 29 B The enormous relative sensitivity due to the multiplied third dimensional feedback provides an extremely effective means of controlling the transmission refer to Fig 6 A, Even a simple internal vane pump 27 could be used as described above for controlling the high ratio component which could be designed for using various methods of governing or speed control by the coupling of it to the body, lubrication, cooling and filtering can be combined. Or any type of suitable similar common pump may be used, such as a Rotorola type, ie coupling a toothed planetary sun gear/part to the body. Internal or external pumping can be combined in this gear for example item 27 in the 6A with for example . One forward rotating cage can extend the "Pulley" system. This drive is a typical example. "In many cases more cages are shown because any type of toothed or other forward rotating planetary gear can be optionally used or combined".

The control housing may be rotating, providing many advantages in control and efficiency which are further able to control as shown with a generator of any type of eddy current device, or feedback motor, accessing any type of energy storage mechanism such as batteries, capacitor, flywheels, electronic control or any other chosen storage (refer to patent, particularly page two). It is further able to be driving both outputs for two wheels. Hybrid operation is also optional as shown driving onto the feedback controlling point, (pulley or chain) or similar. There is also means of providing a kind of "yo-yo" action, see patent.

The ability to optionally use lightweight and non-magnetic materials is very complimentary to this optional design. Fig 29 B The enormous relative sensitivity due to the multiplied third dimensional feedback (Refer to fig 6A where the high ratio cam is shown) provides an extremely effective means of controlling the transmission. This drive is a typical example. The control housing may be rotating, providing many advantages in control and efficiency which are further able to control as shown with a generator of any type of eddy current device, or feedback motor, accessing any type of energy storage mechanism such as batteries, capacitor, flywheels, electronic control or any other chosen storage (refer to patent, particularly page two). It can also drive both outputs for two wheels. Hybrid operation together with all the control, the power sources, regeneration, accumulation is enormously advanced by being able to be put totally on one axis. However, power sources from other axes are able to similarly benefit taking advantage of the above mentioned advances.

The ability to optionally use lightweight and non-magnetic materials is very complimentary with this device, with the ability to produce low cost products such as using moulded or sintered aluminium and steel. Motors designed with complimentary materials would be extremely lightweight such as pancake type or preferably the planned contra-rotating motors. Fig 15, 16, 17. Refer to patent for many optional designs.

Fig 28 B shows one method of a self-contained two wheel transmission, suitable for big or small requirements. The inclusion of hybrid and combined motive power together with a common axis for building robust integrated and self-supporting abilities can revolutionise big and small mobility. The high relative ratios available with the use of this optional design allows the use of only one cage for the forward rotation, however, there are more shown in many cases because of the optional use of toothed or similar gears. The feedback from the high ratio cam/ component makes it possible to provide extremely accurate control of the drive using any type of control, such as generators and eddy current regenerative components for returning energy at a later time. Many types of clutching for recoverable energy can be used, such as combining motor generators with the ability to drive as well as to provide a reverse gear or regeneration requirements. Magnetic particles, polymers may also be combined with electronic control and can be optionally used. The unit is shown encased, however it can be open and the centre engine can be a hybrid combination.

Fig 27 B shows a hybrid drive, operating from an external axes, see Figs 6A, 6C 8B.

Extremely low ratios are optionally in Fig 27 A to provide the low or optionally very low ratios possible. For example low ratios can optionally be made available for many uses as shown in Fig 6B. The ability to provide concentric ratios for any optional use. Combined double ended transmissions, complete with the many different methods are described elsewhere, for providing any necessary ratios. For example, six rollers per cage for five cages provides over six thousand to one ratio all on one axis and extremely compact. Extremely large relative diameters can be further provided. There is the option of having multiple numbers of bodies with bodies, (or scallops), and all the other options, such as changing direction by having one roller more then scallop in the cage/cam, then the same for forward rotation, and then another forward rotating cage/cam if required, and so on, as described. See also Fig 27 for optional designs.

Fig 28 A shows the physical convenience and versatile capabilities, whilst able to all be mounted on one axis, combined with reactive feedback made possible by the torque doubling nature of this compact design, combined with the three dimensional operation in this way. It has the added ability and option to provide free wheeling. In this case by raising (for example) the top lever it allows immediate manual control for emergency turning of the steering wheel. Non corrosive materials can be chosen for salt air conditions.

Fig 27 A shows the compact nature of one optional design, ref Fig 27A above. Extremely low ratios are possible together with having the input shaft turning in the same chosen direction as the output, Together with or without any means of internal or external control of the high ratio cam/component. Any low ratio can be accessible by many different methods and combinations. Bodies with bodies, cam/cages with cam/cages and all the other options mentioned in this patent. Even simple methods, such as coil springs, or vane pumps, or dynamic methods. Double ended with concentric combinations are optional, internal or external control. This concentric option can further combine internal and/or external centrifugal clutches, or by any of the other means described in this patent can be adapted using any multiple means described. The required ratio can be obtained easily providing sensitive control, on one axis, yet further may be totally encapsulated by an optionally rotatable outer case provided by the outer body. Slip rings or brush less electronic couplings for rotating components can provide advanced operations. The added option to combine chosen feature/ratios by "sandwiching", the outer bodies is able to combine other methods of lubrication/control/power sourcing, see Fig 24 A. All the different systems described in

this patent can benefit including hydraulics. This system allows for easy integration of hybrid requirements all on the same axis, this is considered as a major advantage together with accessing the other contra-rotating features described herein. Extremely low cost manufacturing is possible using molded or sintered metal technologies. However, the design can include stationary cages for in-letting or out-letting fuels, liquids, see Fig 7 and 27 A.

Due to the inherent design of this gear, providing displacement, it can incorporate self-contained multi-cylinder rotary engines, oil-pumps and similar. Inlet and outlet ports can be designed to be where needed for the particular operation. The ability is also there to use existing pumps accessing this third dimensional aspect by modification, for example, by modifying their body rotation as described in this patent.

Fig 26 A described earlier in this patent, is an optional design, using, for example, configuration of 4A or Fig 6A, 6C, 6D (shown as No 1 on this drawing by an engineer), shows the variety of design and methods available to use the versatility of compact alternatives allowing for low cost manufacture and installation of power plant and/or replacement possibilities. This patent describes various methods of controlling, however, the design could be extremely efficient and powerful if there already exists a hydraulic system.

Fig 26B shows further either internal control, ie Fig 6A, 6C, 6D (with optional concentric access to item 3b or D6 from either side) or external control for example with a stationary cage for control and/or accumulation of gasses and oils, or similar. It is possible to use an existing pump which has one less roller than scallop, for controlling this power. By securing this pump outer body together with the shaft to any other type of planetary gear body (toothed or otherwise) it will allow, for example, an output cage/cam (or second shaft cam) drive from the pump to drive the first cage of this planetary action. Optionally multiple concentric outputs/inputs could be available for any requirement from one or more following cages or cams. This action could similarly be done using hydrostatic operation, or fluid pressure, or balancing for eliminating metal to metal contact. See also notes on Fig 24. Fig 25 is showing one of the options and the ability to choose the direction of rotation for driving in any chosen direction. This is a self-contained two wheel transmission, perhaps for a train, it can combine multiple, hybrid, and regenerative forces.

Fig 24 refers to and can represent the same as 26A above showing multiple various options, however the ability to combine rotational forces is very easy, such as in putting the added hybrid input onto the clutching shaft, in this case the shaft going to the polymer control.

- HYDRAULICS FIG 24. Shows all the control mechanisms, and variable feedback, which enable combining two separate and varying power inputs, being contained within a single in-line enclosure accessed by a coaxial or triaxial arrangement, ref. Fig 6A, 6D. This ensures that all the forces generated are contained around a single axis. Ref. Fig 26A, 28B.
- 5 The provisional patent of 18-9-98 has as its centre pages the same provisional patent of 14-11-97, including Figs 1,2,3 and 4. The pages 1A to 1E were added to the front of the original main Provisional Patent, with Figs 5, 6, and 7 added to the back. These added pages describe the option of superheterodyning. Pages 22 to 24 were added as well, being combined electronic designers' optional methods. On 10-8-98 these designs for achieving
- 10 some of the applications described in this patent were finalised for prototype manufacturing. The 40 applications of "Wheels Within Wheels" document of 6-6-96 has been included into this patent. For example, items No 3, 6, 9, 10, 18 and 32 describe that this invention has unlimited provision for changing or adding ratios and outputs, by the use of different inserts. Different ratio formulas can be chosen. Refer to Item 32 WWW which describes using
- 15 different inserts in order to achieve this. The inserts could be for the replacement of scallop ring inserts or the replacement of different ratios of cage/s, or alternatively added cages and/or scallop rings.
- Using ratio changing/adding in Fig 24 for say testing combinations of various dynamic requirements, or for example, interfacing with different or unbalanced inputs or outputs, or
- 20 providing more inputs/outputs. One requirement may be for matching or testing different third dimensional feedback from any of the loads, or for matching or changing any of the parameters. The ability to change relative ratios would allow for testing various dynamic qualities. There is also the ability to provide the capability to simply change the relative rotational or travelling speed of any device or other requirement.
- 25 The unique principles and applications for this invention has been described in many ways, such as for the input and integration of rotational power sources, by just rolling them in and/or just rolling them out. This invention also has the ability to combine hydraulics and is able to provide extremely simple, powerful and long lasting machines, which have unlimited combinations and methods of operation.
- 30 Fig 24 can be operated using variations of Fig 6A, and 6D, which are likened to an internal view of the invention which shows the simple operation and internal (or external) pumping which can be provided by the reverse rotation of the cage or double cage (Fig 6A, D6). This is indicated by the double set of lines (Fig 6D) on the planetary cage to the single set of lines

on the forward rotating cage/s. There is the ability to provide internal accumulation with load sensing or governing abilities (which can, for example, extend these abilities by coupling a high ratio cam, planet wheel or component, to the body), together with optionally providing lubrication and cooling. This invention has the ability to operate coaxially as a pulley system. The output may be taken from the body, or a cage can be used to extend this in any dynamic method required. More cages are shown in Fig 24 than are normally needed. This shows optional combinations ie toothed planetary cages, examples of these are available from model shops. However there is the option of providing multiple or any other low ratio/s as required or multiple ratios concentrically if chosen. Hydrostatic balancing can be incorporated by designing the rollers with necessary shapes in order to remove or reduce "metal to metal" contact in any material, or for cushioning. (Many alternatives are described in this patent and the provisional patent.) Refer to WWW particularly items 3, 6, 9, 10, 12, 16, 18, 22, 31, and 32.

Fig 24. Amazingly all the power sources and hybrid components can be totally enclosed, also in Fig, 26A, 28B, together with the option of any type of electronic or wireless remote control system/s. These can be like looking at the invention from an external view. The transmissions can be an integral part of the driving source, sharing lubrication and/or common shaft/axis. Many different forms of internal control and coupling can be employed. Can incorporate Compressors, internal or external Accumulators, Rotary Combustion Engines, refer Page 27, Line 8 Page 62, line 7 and throughout this patent. The coaxial nature of this transmission being able to "pulley" out from the centre in order to make dynamic, reactive corrections, has the potential to provide third dimensional features which can be automatic, by precise design. This third dimensional feedback can be uniquely interactively controlling complex requirements and it can be part of the inherent coaxial design. All the rotational forces, including regeneration can be, incredibly, all on one axis. Many optional advanced methods of mixing electronic and mechanical frequencies can be employed, some are described in this patent, ie page 45. However, the name "Supersonic Heterodyning" described in the pages added to the 1997 Provisional Patent in 1998, originally applied to the historic breakthrough in radio technologies around 1917. This overcame difficulties in receiving and amplifying a large range of frequencies. "Super Heterodyning" is used to 'linearly maximise input to output tuning bandwidth selectability', (including reducing annoying audible squeals.) My invention enhancement of 1998, though not the same as the above, can resemble that major advancement, however it can instead be related to 'maximising mechanical input to output rotational power linearly.'

Fig 18 shows one method of obtaining the feedback referencing in order to contra-rotate any two other components equally such as in Fig 7. However the lower body can as well be controlled, see other Figs, for example Fig 11 for optional splitting of body in order to have total added control, see above also for others.

5 Woods Fans have published figures which show almost 2.5 to 3 times more efficiency for contra-rotating fans in a wind tunnel. This gear can provide lower noise, less wing tip speed, using standard low cost, light weight motors, or various designs such as the use of these high efficiency low cost single motors. See Fig 14, with single or double ended motor gears. Soft starting together with
10 high torque options are available. The entire support structure required can be substantially reduced as well. There can be optionally self supporting gears by body cage or any cam, with combined tunnel fluid guides, see Fig 7, 11, 18, and others.

Fig 17 shows other options, with the option to different ratios - together with the added ability to have the gear have either faster or slower cages within the outer body, in order to
15 capture such things as controlling the relative speed of both wheels in order to apply spin control, or added clutching or braking.

The ability to only need to control the first stage in any way, providing this third dimensional, extended feedback, is absolutely ground breaking, together with the option of having in line multiple integration of other sources of rotational power, i.e. engines/motors,
20 regeneration together, with the ability to be all mounted on the same axis. Not only does this provide the potential for choosing any type of power sources but the added abilities of accessing enormous other regenerative systems such as described in pages 2, 3, 4, 14,15 etc. 14-11-97 of the provisional patent. And also "Wheels Within Wheels" 6-6-96 and see my Australian Patent.

25 Fig 15B, 16B, 27B, 29B illustrate some options, which really shows there are unlimited other possibilities. The further option of hydraulic integration is extremely complimentary with this gear, with any suitable existing pump able to be integrated by modification. If chosen, the ability to inlet and outlet liquids is able to be actuated, for example by a stationary cage, see Fig 7. (See above)

30 (See above Fig 24 and others). This first controlling stage can have, for example, hydraulic valves and timing methods to operate rather than just rollers as shown. Because this is being used as a speed control, as by controlling the flow in any way, we only need to control the first cage relative to the shaft. Very accurate control can be available if required.

Hybrid inputs can all be incredibly coupled in line as shown in Fig 24, 26A, 28B totally on one axis. The addition of a vane pump 27 in D6, Fig 6A and 3b pumping operation, as also shown in Fig 6D, (allowing i.e. governor action) provides the feedback added control, or with the coupling from any suitable rotatable pump. (The ability to use the actual planetary drive to operate as a rotary piston engine is also greatly advantageous because of the inherent design, such as by allowing the outer body to run free with this three dimensional feature, which can allow the combining and accessing of the feedback). Alternatively, the system can be coupled from other axes as optionally shown, Fig 26B, 27B, 29B. If required a stationary cage can be incorporated to inlet and outlet fluids.

Other added rotational forces can be combined and coupled, by the relative rotation of the feedback as shown and the total transmission can be duplicated for driving both wheels, with the added ability to access added internal or external storage systems such as accumulators, or regeneration abilities all on one axis.

High torque contra-rotating electric motors Fig 4, 14, 15, 16, 17 are seen as extremely efficient with one University searching for some way to implement and use their now proven advantages. By starting these motors then varying their relative ratios in order to provide maximum torque, they then can provide high torque eventually reaching any optimum speed to suit the particular requirement. Except for all the various contra-rotating requirements, rotational forces could be designed to turn in the same direction, at which time, any possible wear is eliminated from the gear as they reach 1 to 1 ratios. This optional planetary type gear design can take advantage of this accessing even more efficiencies providing enormous power combined with optional hybrid design accessing the best of chosen power sources (also combines regenerative capabilities). See Fig above for many advanced methods described in this patent, pages 2, 4, 14, 15 etc. Solar energy systems can be likewise benefited as also can fuel cell power sources, see patent.

The inherent torque doubling nature of this gear can be captured by any chosen method, using hybrid designs and can further be designed to provide a means for the traveller returning home even though one source of energy has expired, or can provide non-polluting transport where needed.

Fig 16 shows optional methods of incorporating chosen advantages. The ability to have chosen requirements can be chosen such as in Fig 6A, 6C, will be decided by the application torque requirements, also relating to the particular hybrid and regeneration systems chosen. The hybrid source could be input onto the feedback shown as a clutch drum, this drum can be part of the regenerative system accessing any other stored energy. The drum may be

allowed to motor in order to provide regeneration or a reverse gear or a braking ability.

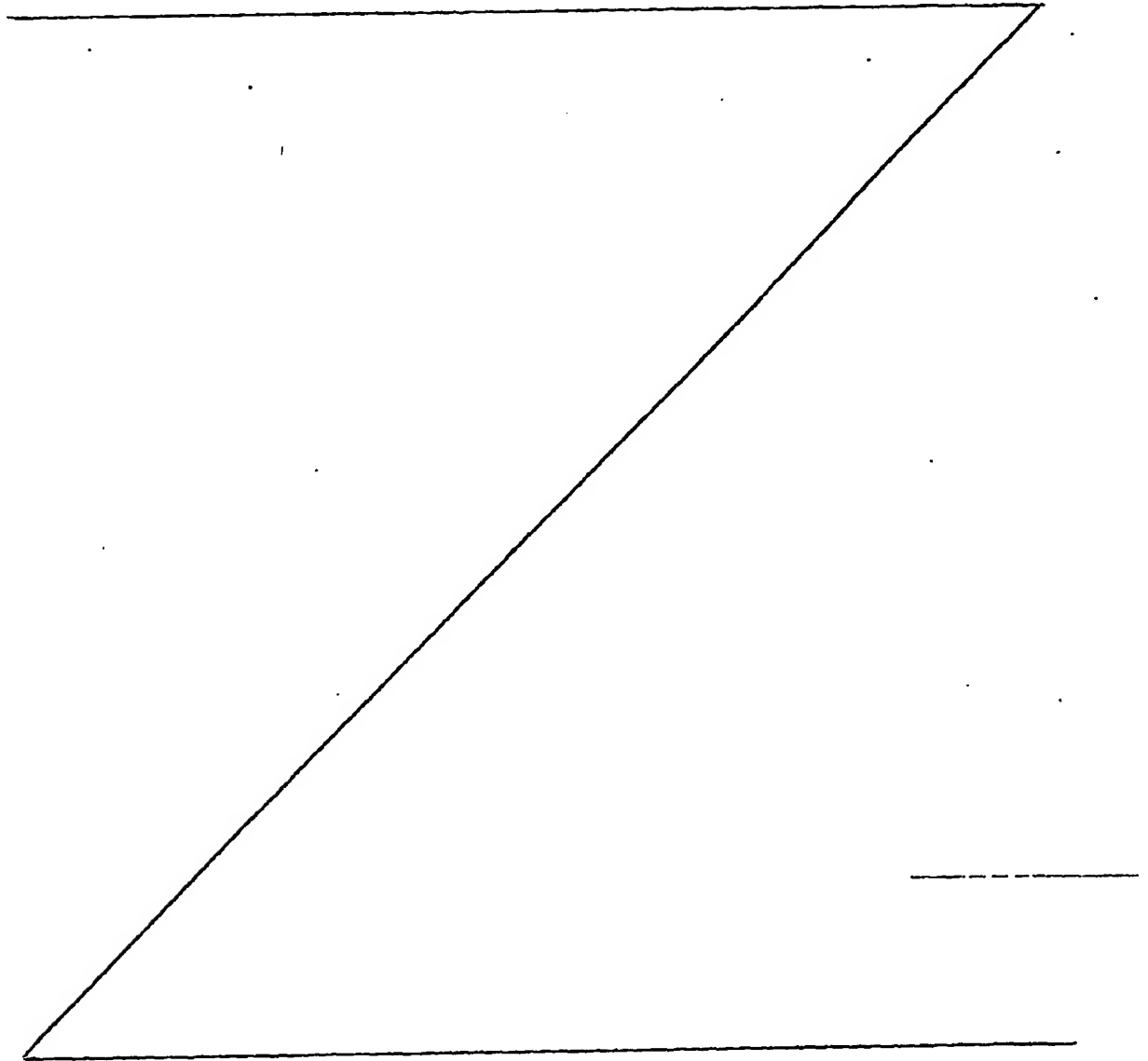
Fig 15 Variations such as cage or outer body output depending on choice, as also with the number of cages chosen. See Wheels Within Wheels items 3, 4, and 12.

5 Fig 14 shows one basic operation for the drives above, however optional contra-rotation abilities for devices such as fans can be achieved by varying the design. For example, by choosing either the cage or body as outputs where required, and also the relative number of rollers to scallops calculated for individual ratios and relative operation in both bodies, contra-rotation will be achieved. It is further able to integrate other rotational forces, and hybrid operation.

10 Fig 12 and Fig 5 illustrates methods of controlling steering and mobility functions for passengers and load. This can be for four wheel vehicles or more operations or for any type of mobile load correction (even three wheelers could be designed for leaning into corners). This is seen as a revolutionary step in total transport comfort and safety with enormous variables such as for every form of mobility. Any size of mobile is equally
15 benefited, with the ability to provide totally new concepts. Safety and comfort combined with the optional use of highly efficient and non-polluting drives, if chosen, as above.

X Fig 11 Other options, these other drawings show a variety of options which are mainly self explanatory, though the enormous advantage of being able to optionally provide almost
→ every needed possibility for optional total control of this transmission.

20 Fig 9 Shows a typical simulation diagram for both designing methods for maximising the output from rotational input force/s, and also ongoing correction to maximising the methods chosen. Or further combining two or more rotational speeds/sources through the gear, using variable source/s for correction in order to maximise and extend maximum linear (or high torque) acceleration from input
25 rotational forces. Also evaluating and accessing the power from other sources such as stored energy and regeneration described in page 2, 3, 14, 15 etc. of both Provisional Patents from 14-11-97, also Provisional of 18-9-98 and Patent 25-5-99, page 2, 4, 14, 15 etc.



WHEELS WITHIN WHEELS 6-6-1996

Examples of the uses for the multi drive gear are indicated in the following pages but is not limited to these applications

1 FANS

30. This gear has the ability to reduce the motor size to a quarter of the existing sizes in some commercial situations, which as a result, require much cheaper mechanical structure to accommodate them as well, the motors also being about a quarter of the price. With further built in advantages as follows: -

2. CONTRA-ROTATION

Many uses for this feature, but for fans, brings with it the increase in efficiency of wind pressure of about 250% - 300% just for the extra cost of the extra impeller.

3. COMPRESSORS

- 5 This device can provide a no-load start combined with a centrifugal clutch working at an extended range. Disadvantage- more parts are needed, but the wear would only occur on start up and the clutch would not get the wear of a conventional one, because of the gearing. NOTE new designs of compressors are described below.

4. MINI-BIKES / GOKARTS ETC

- 10 This gear combination/clutch would be able to provide a drive system somewhere between the present centrifugal clutch used, priced at \$50 and the "Daff" type transmissions selling for around \$400. This gear, with centrifugal clutch is expected to be between \$80 and \$120. Wear only occurs when actually starting and stopping, but would be much less than the centrifugal clutch alone, due to this gear. NOTE: new alternate transmission designs are described below.
- 15

5. STEERING WHEEL DRIVE for such things as AUTO PILOTS

- It provides a one piece unit with built in over-ride and clutch if required. Allowing the driving motor to be easily mounted and can also do away with linkages, chain drives etc. The advantage of being able to produce it from non corrosive material can be very advantageous in salt air conditions. RUDDER DRIVES are also convenient to fit by using this gear at a pivot point.
- 20

6. PUMP COMBINATION

- There are several ways which this gear can provide displacement in order to provide a pumping action, either internally, or as an integrally manufactured part. The pump can also provide SPEED CONTROL for the output drive of this gear output itself (as described further in this summary, which really only covers some of the uses thought of to date)
- 25

7. LAWN MOWERS

- There are many alternative requirements for this product for such things as requiring just one motor with this gear to provide multiple outputs, directly on the end of the motor shaft.
- 30 One output can drive the wheels at perhaps 40:1 ratio whilst another one (or more) will drive the blade/s at 6:1 and another to provide a reversing action. Many other drive options are available such as, two manually operated speeds and clutch can be easily achieved.

8. WASHING MACHINE GEARBOXES

These can be easily manufactured, of which I am informed by the manager of a company

who claims to have manufactured 70% of Australian gearboxes in the past (they are now made overseas). This company now only has a small percentage of the market; they are very anxious to get involved with this gear as their manufacturing system is very complementary and cost effective for this gear.

5 9. HIGHER TORQUE MOTORS

Able to incorporate this gear to produce extremely efficient drive systems. The motor could utilise new types of magnets such as "rare earth" type which could be an integral part of the gear so that a maximum relative circumference providing maximum torque is available to optimise the drive and also may incorporate speed control by magnetic, mechanical and/or
10 electronic means.

10. UNIVERSAL EXTREMELY COMPACT HIGH RATIO REDUCTION GEAR

This is very cost effective as it merely requires a duplication of the internal components which effectively are multiples of the chosen ratios. There is also the ability to provide multiple output and inputs where required as well, for such things as heterodyning.

15 11. LIFTS

Common cheap AC motors can be used utilising extremely low current controllers to smoothly supply optimum power to this gear, avoiding the high cost of modern solid state speed controls, in which all the current to control the motor has to be handled by expensive specialised equipment. The alternative older systems for lifts required D.C. motors to be
20 supplied by auxiliary, 'costly to install, maintain and run equipment', which are themselves being upgraded to these costly new systems, (which are also rapidly becoming obsolete as changes are planned and made).

12. AUTOMOTIVE

Automatic transmission could use this gear and by simply extending the range of a
25 centrifugal clutch or by the use of magnetic control (electronically or mechanically controlled) which would provide extremely low cost drives. The use of a torque feedback in our system is simpler than the recent French patent, and is also more feasible than the toothed epi-cycle type in their patent because we would not have to have a double reduction with this compact gear design.

30 13. HELICOPTER

Extremely compact lightweight propeller drives, plus the great advantages of contra-rotation could not only provide more efficiency the added advantage of being able to control direction without the need for the present tail propeller. This could drive a simple one-man

machine or highly maneuverable and powerful craft.

14. DRILLING MACHINES

Load sensing could allow for releasing or freeing operations. The ability to push other materials up or down is also unique, perhaps whilst drilling is in action. The ability to
5 contra-rotate and provide a balancing and/or torque doubling, could be employed in perhaps delicate operations such as human body bone operations.

15. SPACE TECHNOLOGY

Could have light weight gears for almost any thing such as balancing or feed back sensing of lifting lids, or actions in space which usually need gravitational references. Extremely
10 versatile maneuvering mobiles and robotics are possible, including climbing and walking.

16. MEDICAL

Implantable orthopaedic prosthesis could incorporate miniaturized variable speed gears, i.e. for skeletal movement in joint replacement. Materials could be inert tantalum, and together with a sealed gear would enable efficient performance. Reactive touch sensitivity could also
15 be included.

17. MARINE

There are several advantages with this gear over existing drives, the gear can provide a gear reduction at the tail shaft of the motor together with an optional clutch, or a reverse gear. A second gear can provide a reduction and a contra-rotating action on the propellers providing
20 an expected 3 times the efficiency, combined with the ability to reduce the speed of the propeller/s which also allow for a more efficient propeller size. The option of using non-corrosive materials, as well as possibly under-water use is also a great advantage.

18. INDUSTRIAL

Variable speed or fixed speed gearing, conveyor belts with ease of ratio changes, through to
25 complex machinery. Lifting or measuring equipment can be simply made with optional vernier type control for accurate operations with say, two inputs drives/motors, or load sensing can be provided.

19. CRANES

Automatic load shifting by sensing the load with the inbuilt feedback provided, in order to
30 keep the crane at the optimum point of balance.

20. ROBOTICS

The unique feedback can provide touch sensitive control for robotics. This can also allow for the equalising and balancing of loads, as an example animations can be made to climb stairs.

21. AGRICULTURE

Many farm machines require simple low cost gearing and there could be numerous uses for a range of sizes available to the farmer, to say, wind-in fences, lift gates, lift machinery etc. The spraying of crops could have a very efficient system which would atomise the spray say, ejecting it out between contra-rotating fan blades providing a very wide coverage.

22. MOTORISED WHEEL

This unit has a demonstrable torque multiplying ability which has been partly used by the planetary or epicycle type motor wheel drives such as Eaton drives, and similarly to automatic transmissions in cars providing a greater accelerating than manually controlled gears. Because of the revolutionary compact and low cost nature of our design, one aim is now to exploit every variation of the powered motor wheel possible.

23. LIFTING LIDS, OPENING GATES

The difficulty experienced in the past has been the need to provide enormous power at the pivoting points to accomplish this, resulting in clumsy and expensive devices like rams, these are intrusive and space taking, not to mention that people can walk into them on windows etc. This gear provides an alternative to these devices and is able to be driven directly without having dangerous chains etc. Gates may be pivoted and using this drive, say, at the hinge centre, compact operation is provided. Another option for FARM GATES could be to lift them at the end similar to a railway crossing, if this is operated by remote control, a farmer could see the opening gate from a distance. Such remote operations are able to be powered by battery and solar energy charging, allowing for low installation cost and maintenance free use for many years.

24. BED LIFTERS FOR HOSPITAL AND HOME

This product makes it possible to provide removable bed lifting mechanisms which can be moved onto any existing bed. The only bed lifter available is built into the bed at present because of the large normal mechanics required as with the gate openers above. The cost of these beds are a minimum of about \$2500. The Paraplegic Society liked my demonstration of the bed lifters which I demonstrated to some of their top people recently, they are waiting for some to test and also advised me to demonstrate it to the larger marketing organisations because they could see a great need for it. One of the main advantages is to protect nurses backs when lifting patients up.

25. TRAIN DRIVE

Great advantages including flywheel effect described in information contained on page 6 of

Document 1 (Variable Speed Gear).

26. POWER TOOLS

5 The required drive can be directly mounted on the motor shaft making it easy to support without other gearing necessary because of this product's simple principle. A clutch may be manually operated such as a squeezing action or automatically provided. This clutch may provide a combination of over-load protection and speed or sensitivity control coupled to maximum torque.

27. DENTAL/MEDICAL TOOLS

10 As above and can provide compact or miniaturisation combined with a touch sensitive feedback to control torque.

29. STAIR CLIMBING

This has proved very difficult in the past for animation, but by using feedback of the legs to balance and lift the body evenly the two relative legs (as an example) could provide balance.

30. DIFFERENTIAL

15 The wheels on the road work like the feedback to each other and thereby can keep the wheel speed to a chosen relative RPM.

31. MICRO-MACRO

20 Because of our computer program and design it would be easy to make in micro sizes. The design makes powerful smaller drives, the larger the size, the more cost effective this product can be.

32. RATIOS

This gear has the ability to change or add more ratios and outputs using different inserts.

33. RESCUE WINCHES

These could lift the load according to the weight.

25 34. SKYSCRAPER ESCAPER SYSTEMS

These could automatically clutch or slow the descent as the weight increases.

35. AUTO-WINDOW WINDERS

Could do away with the old toothed semi-circle winders.

36. PROPELLER

30 The propeller pitch can be controlled by the feedback to get maximum thrust.

37. WINDMILLS

These can start to turn sooner if the rotor blade/s are at a greater pitch, to start or alternatively contra-rotating blades. The front blade can be used to simply start the

momentum of the rear before there is enough wind speed to start the load as the wind increases, the rear blade slows down and instantly there would be torque supplied to load.

38. BICYCLES

5 The torque doubling feature could be used to provide two speeds or other mechanical torque advantages.

39. EXERCISING GYM EQUIPMENT

Could give auto equalising to arm reactors or leg or body balancing. Could also provide rowing simulators with accelerated water splash baths. Weights could be reduced substantially.

10 40. TOYS AND RIDE-ON EQUIPMENT

An endless list of these could use the compact low priced advantage of this product, making many exotic and unique features possible.

15 It will be appreciated that modification and alteration can be made to the present invention as described above without departing from the inventive concept as defined in the following claims.

CLAIMS

CLAIM 1

A variable transmission system based around one central axis and able to control and feedback from or to any other axis, comprising an input and an output; a differential mechanism having a first access, a second access, and a third access, the differential mechanism defining a first transmission ratio and a second transmission ratio, the rotational speed of the output relative to that of the input varying during operation according to the second ratio than during operation according to the first ratio selective coupling means comprising at least a first selective coupling means for effecting the change from the first ratio to the second, the first selective coupling means having a driving member and a driven member and being of a type which allows relative angular slip between the driven member and the driving member as a function of torque transmitted between the members and rotational speed of the driving members; means for connecting the input of the transmission to the driving member of a first selective coupling means independently of any of the accesses of the first side of a double differential mechanism; means for connecting the output of the transmission to the first access of the first side of a double differential mechanism; means for connecting the driven member of the first selective coupling means to the second access of the first side of a double differential mechanism; means for connecting the input of the device to the third access of the first side of a double differential mechanism independently of the first selective coupling means; and means for preventing the second access from rotating backwards during operation according to the first transmission ratio providing the first transition ratio driving a load with the first sun-gear being able to be toothed, compact roller, or any design, having a double ring gear and double planet carrier, forming a double differential and double torque multiplier wherein all of the differential components are

contained within a single housing which is in itself a part of the first stage differential, with the ability to support and be integral members inside or outside of the driving source or sources or with the load, being able to share lubrication, and further able to provide automatic speed and governing abilities because the rotation speed of the double differential has fixed ratios relative to the power source and fixed ratios relative to the load, therefore, unlike all previous technology, is able to provide self contained, self regulating transmission systems with in-built or external centrifugal clutching or pumping and governing in order to control the second sun gear which control provides the second driving transition for the load to reach a maximum design ratio, when the sun gear is stopped, whereby more than one input source or load is able to be integrated, as also are more dynamic extensions able to be coupled with means for reversing the load and having stationary references from either end for one way braking clutching control or freewheeling.

CLAIM 2

A variable transmission system as described in Claim 1 where the internal reverse direction of rotation may be provided by means such as a roller cage having fewer rollers than number of scallops in the scallop ring than in the normal direction roller cage, which cage requires more rollers than scallops, alternatively, a suitably designed planetary type of pump having fewer rollers than scallops can be used in a similar method providing similar internal reverse direction of rotation, with or without retaining the pumping ability, or any other planetary design able to provide the internal reverse ability such as a planet carrier supporting pairs of toothed planet wheels between the sun gear and ring gear for reversing the carrier direction, these will be referred to as reverse cages,

wherein they can be coupled, with provision for one or more inputs and outputs, incorporating the body which is able to be extended and/or laminated to another body, and is able to rotate about a first axis coincident with the axis of the body, with a first toothed ring gear or scallops ring gear, a second or more set of scallops on its internal wall, or alternatively, with toothed ring gears, or similar, able to be laminated or fixed to the body of a first inner ring gear, to suit these and other designs of planetary gears, yet being able to remain as a single body, having a central shaft co-axial with the body and able to rotate about the first axis, a first inner reverse cage, partially or wholly enclosed by the body and constrained to rotate about the first axis, a second outer cage, being partially or wholly enclosed by the body and constrained to rotate about the first axis, with a first inner cam, or planet wheel fixed to the central shaft between the central shaft and the first inner reverse cage a second outer cam, or toothed planet wheel, between the central shaft and the second outer cage, or planet carrier constrained to rotate about the first axis, with a first inner set of rollers constrained by the first inner cage or reverse cage to be between the first inner cam and the first inner toothed ring gear or set of scallops of the body, having one less number of rollers than scallops, with a second outer set of rollers constrained by the second outer cage to be between the second outer cam and the second outer set of scallops of the body having one more roller than scallops, wherein the first inner cage, or reverse cage and the second outer cage are fixed to each other so as to be constrained to always rotate at the same angular velocity and in the same direction forming a double cage rotating in the reverse direction to the direction of the first inner cam or planet wheel, and being able to be about the first axis, wherein the double reverse cage, in Fig 6D, 6C, 6A, 4A, 6, is able to have any chosen alternative planetary design, such as toothed planet carriers for either side, able to be used instead of the second outer cam shown in Fig 6A, which can be used within a crown ring gear, itself being fixed to the left hand side of the first body, wherein the body is able to rotate in as many full rotations as required in either direction for coupling to the load, with a further provision to extend or laminate the first body, by fixing another planetary body onto the right hand side of the first body, making provision for a number two inner cam, sun gear or planet wheel fixed to the central shaft, able to be about the first axis, wherein the number two cage or planet carrier is between the cam and body, in order to provide dynamic extensions to the particular design, or for centrifugally equalising or circulating any contents, or in order to enhance progressive control, governor action, loading up, or any overdrive features, being extended by the added

cage, of any type, wherein the body, double reverse cage and outer cam, will rotate in a reverse direction when a torque is applied to the central shaft, with the added cage held stationary, which cage can alternatively be multiple incorporating any number of cams.

CLAIM 3

5 A variable transmission system using the three known common planetary components, including a sun gear, planet wheel or cam, together with a planet carrier or roller cage of any design, with a crown ring gear or scallop ring of any design used as a body and providing the normal external reverse rotation of the body, whether toothed, roller or other design with similar direction of rotation operation, being integrated with or coupled to, internal reverse
10 direction of rotation planet carriers provided by means such as, a roller cage having instead fewer rollers than number of scallops in the scallop ring than in the before-mentioned roller cage, which cage requires more rollers than scallops, alternatively, a suitably designed planetary type of pump having fewer rollers than scallops can be used in a similar method providing similar internal reverse direction of rotation, with or without retaining the
15 pumping ability, or any other planetary design able to provide the internal reverse ability such as a planet carrier supporting pairs of toothed planet wheels between the sun gear and ring gear for reversing the carrier direction, these will be referred to as reverse cages, wherein they can be coupled, with provision for one or more inputs and outputs, incorporating the body which is able to be extended and/or laminated to another body,
20 and is able to rotate about a first axis coincident with the axis of the body, with a first toothed ring gear or scallops ring gear, a second or more set of scallops on its internal wall, or alternatively, with toothed ring gears, or similar, able to be laminated or fixed to the body of a first inner ring gear, to suit these and other designs of planetary gears, yet being able to remain as a single body, having a central shaft co-axial with the body and able
25 to rotate about the first axis, a first inner reverse cage, partially or wholly enclosed by the body and constrained to rotate about the first axis, a second outer cage, being partially or wholly enclosed by the body and constrained to rotate about the first axis, with a first inner cam, or planet wheel fixed to the central shaft between the central shaft and the first inner reverse cage a second inner cam fixed to the centre shaft between the central
30 shaft and the second inner cage, constrained to rotate about the first axis, with a first inner set of rollers constrained by the first inner cage or reverse cage to be between the first inner cam and the first inner set of scallops of the body having one less number of rollers than scallops, a second inner set of rollers constrained by the second inner cage to be between the

second inner cam and the second set of scallops of the body having one more number of rollers than scallops, or alternatively other common planetary designs can be used instead for the second inner cam such as a toothed planet wheel and planet carrier which can be used within a crown or ring gear itself being fixed to the first body, of any type, with the ability to extend either side of the body, wherein the body is able to rotate as many full rotations as required in either direction for both static and dynamic requirements being the result of chosen relative numbers of cages and chosen ratios of rollers, cages and bodies, with the further provision for body extensions to provide for multiple concentric inputs and outputs using for example various combinations of cages with cams, with the further ability for alternatively combining the advantages and operations of the double cage with its second outer cam, or planet wheel, as described in claim 1 and 2.

CLAIM 4

A variable transmission system as in claim 1 to 3 suitable for low speed or very high speed, not needing a body frame, with dynamically configurable variable ratios of input to output and having one or more inputs and outputs and with all components free to rotate about its axis, wherein the components comprised by the transmission can move, with rotation of one or more of its inputs and outputs, with relative angular velocities with respect to each other that are substantially less than the angular velocities, about the axis, of the components with respect to a point fixed in space, thus providing efficient conversion of torque without losses normally associated with having components that are in contact with one another, moving at high speeds relative to each other.

CLAIM 5

A variable transmission system as in claim 1 to 4 which is dynamically configurable with variable summation or subtraction of variable input energies, also having all the rotational input and output forces on one axis, including means for internal and external regeneration and accumulation of fluids, gasses, liquids and other means, with unlimited choice of internal or external clutching mechanisms whether hydraulic, pumping, mechanical, magnetic, including centrifugal or governor action with many options, such as one way clutches with the choice of progressive clutching, or high speed controlling of the couplings such as with polymers and electronic remote control with the ability to couple multiple types of energy sources, rotational forces and/or regenerative forces in series using common shafts if chosen, or multiple shafts in series.

CLAIM 6

A variable transmission system, as claimed in any of the Claims 1 to 5 or substantially as described herein or with reference to any drawings in order to access and return energy from any other axes as well, together with internal or external regeneration and accumulation.

5 CLAIM 7

A variable transmission system, as in claim 1 to 6 with a first inner cam and a first body able to include pumping if required, there being the further ability to incorporate a second, No. 2 inner cam fixed to the centre shaft in order to extend any required operation by combining a second cage able to also include pumping if required, with the added ability to
10 have an body extension, directly coupled to the first body forming one single body, providing added optional abilities and/or dynamic enhancement allowing one-ended support for transmissions by a stationary or controllable cage so that the opposite end does not need support with the outputs available between the opposite side body and cage, able to provide equal contra-rotation or any required ratios, allowing for any type of rotational,
15 reciprocating or other controlling methods concentrically and also through the centre of the centre shaft, with the further ability for bodies to be separated, operating independently so as to provide for additional control on the separated bodies as well as described and as in the drawings, with the further provision for body extensions to provide for multiple concentric inputs and outputs using for example various combinations of cages with cams, with the
20 further ability for alternatively combining the advantages and operations of the double cage with its second outer cam, or planet wheel, as described in claim 1 and 2.

CLAIM 8

The variable transmission system of any of the Claims 1 to 7 wherein a torque available from an output of the body can be at a maximum when the angular velocity of the body is
25 zero and the torque decreases as the angular velocity of the body increases.

CLAIM 9

A variable transmission system as in Fig 1 to 8, having a double planet carrier cage for reverse operation, which may alternatively use other planetary designs such as toothed planet carriers with double planet wheels in the first inner carrier and normal single planet
30 wheels in the second outer carrier, or any other planetary design may be combined or different planetary designs used able to achieve similar operations, where the number of rollers in the first inner set of rollers and the number of scallops in the first inner set of scallops having been set such that the first inner cage would rotate with a lesser angular

velocity than the central shaft when the central shaft is caused to rotate through application of a first externally supplied torque and were the body to be fixed through application of a second externally supplied torque, the number of rollers in the second outer set of rollers and the number of scallops in the second outer set of scallops having been set such that the second outer cam, planet wheel, or sun gear, rotates with a greater angular velocity than that of the first inner cage were the body to be fixed through application of the second externally supplied torque while the first externally supplied torque is applied.

CLAIM 10

A variable transmission system as in any of the Claims 1 to 9, wherein the number of rollers in the first inner set of rollers and the number of scallops in the first inner set of scallops are such that the double first inner cage rotates in the reverse direction to that of the rotation of the central shaft and with an angular velocity which is $1/N$ of that of the central shaft measured with the body stationary, where N is a number which can be determined from the number of rollers in the first inner set of rollers and the number of scallops in the first inner set of scallops, the number of rollers in the second outer cage and the number of scallops in the outer set of scallops is set such that the second outer cam, or planet wheel, will rotate in the reverse direction to that of the rotation of the central shaft and with an angular velocity which is M/N of that of the central shaft, measured with the body stationary, where M is a number which can be determined from the number of rollers in the second outer set of rollers and the number of scallops in the second outer set of scallops, with similar calculations being able to be made if toothed or other planetary designs are used or combined.

CLAIM 11

A variable transmission system, as claimed in Claim 10, in which when a first motor drive is connected to the central shaft causing the central shaft to rotate with an angular velocity $A1$, a second motor drive is connected to the second outer cam or planet wheel, causing the central shaft to rotate in the reverse direction to that of the central shaft and with an angular velocity $A2 = A1 \times M / N$, the body will not rotate and furthermore, variation of the speed of the first motor drive or the second motor drive or both such that $A2$ is not equal to $A1 \times M / N$ will cause the body to move with an angular velocity which is a fraction of the difference between $A1$ and $A2$, providing the means of precise control of angular velocity and angular position of the body, and a torque advantage in the torque available at the body over the torques from the first and second motor drives.

CLAIM 12

A variable transmission system, as in any of the Claims 1 to 11, an input wherein there being a pump connected to the central shaft which pressurises fluid which in turn increases the loading between the body and the chosen component pumping design of the second
5 outer cam, or chosen component pumping design of a planet wheel within a double cage/planet carrier, so that when the centre shaft turns faster the pump pumps faster and the load or coupling between the body and the second outer cam is therefore increased, increasing the loading on the central shaft which tends to slow the centre shaft, there being a chosen pressure regulating point, or any other type of internal or external control, allowing
10 the centre shaft to vary the rotation of the body, which will centrifugally provide greater or lesser loading allowing the dynamic ability for centrifugal action to allow for various governing and speed controlling operations to work in a self regulatory manner, providing fully self contained control, with the loading between the body and the second outer cam reducing allowing the increase in speed of the centre shaft, allowing the driving source to
15 gain speed thus providing higher torque, there being many methods of control due to the dynamic operation of this transmission.

CLAIM 13

A variable transmission system, as in any of the Claims, 1 to 12, and further incorporating any number of cages able to rotate about the first axis and each cage wholly or partially
20 enclosed by the body, means between the central shaft and any number of the cages, means between the body and any number of the cages, means between the cages in any sets of combinations of any of the cages, wherein each input and each output is applied to or taken from one of the body, the central shaft and any number of the cages, and application of a first torque to the central shaft causing the central shaft to rotate about the axis while torques
25 are applied, about the first axis, to any number of the cages will cause at least one of the cages and the body to rotate and, furthermore, variation of one of the torques between zero and a maximum value will cause a variation of the ratio of the angular velocities of the central shaft and the body through the actions of the means.

CLAIM 14

A variable transmission system, as in any of the Claims 1 to 13 , and incorporating a
30 reactive "third-dimensional feedback" or "dynamic" means, wherein the variation of the angular velocity of the central shaft causes a variation of the amount of torque applied to the second outer cage by the body through the action of the reactive "third-dimensional feedback" or dynamic means.

CLAIM 15

A variable transmission system, as claimed in Claim 1 to 14, wherein an increase in the angular velocity of the central shaft produces an increase in the amount of torque applied to the second outer cage by the body through the action of the reactive "third-dimensional feedback" or "dynamic" means.

CLAIM 16

A variable transmission system, as in any of the Claims 1 to 15, and also incorporating a reactive "third-dimensional feedback" or "dynamic" means, wherein the variation of the angular velocity of the second outer cam causes a variation of the amount of torque applied to the first inner cage by the body through the action of the reactive "third-dimensional feedback" or "dynamic" means.

CLAIM 17

A variable transmission system, as claimed in Claim 16, wherein an increase in the angular velocity of the second outer cam produces an increase in the amount of torque applied to the first inner cage by the body through the action of the reactive "third-dimensional feedback" or "dynamic" means.

CLAIM 18

A variable transmission system, as claimed in any of the Claims 1 to 17 and incorporating a reactive "third-dimensional feedback" or "dynamic" means, wherein the variable input angular velocity of the first inner cam is varied according to the angular velocity of the output through the action of the reactive "third-dimensional feedback" or "dynamic" means.

CLAIM 19

A variable transmission system, as claimed in any of the Claims 1 to 18 and incorporating a reactive third-dimensional feedback means, wherein the variable input angular velocity of the second outer cam is varied according to the angular velocity of the output through the action of the reactive "third-dimensional feedback" or "dynamic" means.

CLAIM 20

A variable transmission system, as claimed in any of the Claims 1 to 19 and also incorporating a means of storing and returning rotational and accumulated energy of the system in which the transmission is incorporated, there being provided various and/or progressive means of coupling between transmission components and input rotational forces so as to couple to the second outer cam, the double cage the shaft, or any specially designed cage or body for different described operations with different types of coupling methods such as various clutches and/or polymer actions, including high speed switching.

CLAIM 21

A variable transmission system, as claimed in Claim 20 in which the means of storing and returning rotational energy is in the form of a flywheel, with a significant moment of inertia and either housed within the body, or without the body, with the option of substituting the flywheel, or adding to it with any other forms of stored energy such as starter/generators/motors or similar, superchargers, lifting weights, coil springs, there being provided various and progressive means of coupling between transmission components and input rotational forces so as to couple to the second cam, the double cage the shaft or any specially designed cage or body, for different described operations with different types of coupling methods such as various clutches and/or polymer actions, including high speed switching.

CLAIM 22

A variable transmission system, as claimed in Claim 20 in which the means of storing and returning accumulated energy internally or externally is in the form of gasses and fluids providing lubrication, control, cooling, filtering and cushioning or eliminating metal to metal contact on any materials, with alternative means of control, either totally self contained with means of automatic or centrifugal actions or with a stationary component with means of passing energy when required, there being provided various and progressive means of coupling between transmission components and input rotational forces so as to couple to the second cam, the double cage the shaft or any specially designed cage or body, for different described operations with different described types of coupling methods such as various clutches and/or polymer controlling actions, including for high speed switching.

CLAIM 23

A transmission system, as claimed in Claim 20 in which the means of storing and returning rotational energy is in the form of an electrical generator and motor, and electrically connected to a means of storing and returning electrical energy when required to do so, there being provided various and progressive means of coupling between transmission components and input rotational forces so as to couple to the second cam, the double cage the shaft or any specially designed cage or body, for different described operations with different types of coupling methods such as various clutches and/or polymer actions, including high speed switching.

CLAIM 24

- A variable transmission system including a torque multiplier with an input to output ratio that is continuously variable between a first ratio and a second ratio, comprising;
- 5 a first epicyclic gear consisting of a first sun gear, a first planet carrier carrying a first set of planet gears and a first ring gear, arranged such that the planet carrier would, if allowed, rotate in the opposite direction to the rotation of the sun gear and with a fixed ratio of angular velocities of the first sun gear and the first planet carrier if the first ring gear is held fixed;
- 10 a second epicyclic gear consisting of a second sun gear, a second planet carrier carrying a second set of planet gears and a second ring gear such that the planet carrier would rotate in the same direction as the rotation of the sun gear and with a fixed ratio of angular velocities of the second sun gear and the second planet carrier if the second ring gear is held fixed;
- a first input/output means fixed to the first sun gear;
- 15 a second input/output means fixed to the second sun gear;
- a first input/output means connected to the ring gear;
- a reference means for reference to a zero of angular velocity;
- a unidirectional means, fixed to the reference means, arranged to prevent the rotation of the first and second planet carriers in a direction opposite to that of the first sun gear; and
- 20 a variable clutch means to vary engagement between the second input means, along with the second sun gear, and an element of the transmission whose angular velocity is not in the direction opposite to that of the input means;
- wherein;
- 25 the first and second ring gears are fixed together in such a way as to constrain the first ring gear to have substantially the same angular velocity as that of the second ring gear at all times; and
- the first and second planet carriers are fixed together in such a way as to constrain the first planet carrier to have substantially the same angular velocity as that of the second planet carrier at all times, whereby there is formed a double differential action and
- 30 the first ratio is attained when the first sun gear is rotated along with the input means, the variable clutch means is disengaged and the first and second planet carriers are

stationary, prevented from rotating in the direction opposite to that of the input means by the unidirectional means;

the second ratio is attained when the variable clutch means is engaged so as to cause the first and second planet carriers to rotate at the same angular velocity as the
5 element of the transmission whose angular velocity is not in the direction opposite to that of the input means;

the input to output ratio is variable continuously between the first ratio and the second ratio through varying a degree of engagement of the variable clutch means;

the angular velocities of the first output means and one of the input means being
10 continuously variable by varying the angular velocity of the other input means; and

the first and second sun gears, the first and second planet carriers and the first and second ring gears are able to rotate about a first axis of the transmission.

CLAIM 25

A variable transmission system in the form of a torque multiplier with an input to
15 output ratio that is continuously variable between a first ratio and a second ratio, comprising;

a first epicyclic gear consisting of a first sun gear, a first planet carrier carrying a first set of planet gears and a first ring gear, arranged such that the angular velocities of the first sun gear, the first planet carrier and the first ring gear obey the relationship
20 expressed by a first equation,

$$\omega_{cage} = \frac{\omega_{ring}(R_N + 1) - \omega_{sunN}}{R_N}$$

wherein ω_{cage} represents the angular velocity of the first planet carrier, ω_{ring} represents the angular velocity of the first ring gear, ω_{sunN} represents the angular velocity of the first sun gear and R_N is a constant whose value is determined by the arrangement of
25 the first sun gear, the first planet carrier and the first ring gear;

a second epicyclic gear consisting of a second sun gear, a second planet carrier carrying a second set of planet gears and a second ring gear arranged such that the angular velocities of the second sun gear, the second planet carrier and the second ring gear obey the relationship expressed by a second equation,

$$\omega_{cage} = \frac{\omega_{ring}(R_M - 1) + \omega_{sunM}}{R_M}$$

wherein ω_{cage} represents the angular velocity of the second planet carrier, ω_{ring} represents the angular velocity of the second ring gear, ω_{sunN} represents the angular velocity of the second sun gear and R_M is a constant whose value is determined by the arrangement of the second sun gear, the second planet carrier and the second ring gear;

- 5 a first input/output means fixed to the first sun gear;
a second input/output means fixed to the second sun gear;
a first input/output means connected to the ring gear;
a reference means for reference to a zero of angular velocity;
a unidirectional means, fixed to the reference means, arranged to prevent the rotation of the
- 10 first and second planet carriers in a direction opposite to that of the first sun gear; and
a variable clutch means to vary engagement between the second input means, along with the second sun gear, and an element of the transmission whose angular velocity is not in the direction opposite to that of the input means;
wherein;
- 15 the first and second ring gears are fixed together in such a way as to constrain the first ring gear to have substantially the same angular velocity as that of the second ring gear at all times; and
the first and second planet carriers are fixed together in such a way as to constrain the first planet carrier to have substantially the same angular velocity as that of the second planet
- 20 carrier at all times;
the first ratio is attained when the first sun gear is rotated along with the input means, the variable clutch means is disengaged and the first and second planet carriers are stationary, prevented from rotating in the direction opposite to that of the input means by the unidirectional means;
- 25 the second ratio is attained when the variable clutch means is engaged so as to cause the first and second planet carriers to rotate at the same angular velocity as the element of the transmission whose angular velocity is not in the direction opposite to that of the input means;
the input to output ratio is variable continuously between the first ratio and the second ratio
- 30 through varying a degree of engagement of the variable clutch means;
the angular velocities of the first output means and one of the input means being continuously variable by varying the angular velocity of the other input means; and

the first and second sun gears, the first and second planet carriers and the first and second ring gears are able to rotate about a first axis of the transmission.

CLAIM 26

5 A variable transmission system, as in Claim 25, wherein the first and second epicyclic gears are of the roller bearing type and the constant R_N is equal to the number of sets of rollers in the first epicyclic gear and the constant R_M is equal to the number of sets of rollers in the second epicyclic gear.

CLAIM 27

10 A variable transmission system, as in Claim 24, wherein the second input means is connected to a feedback means which varies the angular velocity of the second input means according to the angular velocity of the output means.

CLAIM 28

15 A variable transmission system, as in Claim 25, wherein the second input means is connected to a feedback means which varies the angular velocity of the second input means according to the angular velocity of the output means.

CLAIM 29

20 A variable transmission system, as in Claim 26, wherein the second input means is connected to a feedback means which varies the angular velocity of the second input means according to the angular velocity of the output means.

CLAIM 30

A variable transmission system, as in Claims 24, 25, 26, 27, 28, and 29, wherein there is a one way clutch which prevents the negative rotation of the first input means.

CLAIM 31

25 A variable transmission system, as in Claims 24, 25, 26, 27, 28, 29, and 30, wherein there is a variable clutch means between the second sun gear and the second ring gear.

CLAIM 32

A variable transmission system, as in Claim 31, wherein there is a variable clutch means between the second sun gear and the second planet carrier.

CLAIM 33

30 A variable transmission system as in Claim 31 whereby there is a variable clutch means between the second sun gear and a fixed reference point within the machine in which the transmission is mounted.

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CLAIM 34

A variable transmission system, substantially as described herein.

CLAIM 35

A variable transmission system, substantially as described herein with reference to any one or more of the accompanying drawings.

5

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ABSTRACT

5 A gear ratio set including a centre shaft, cage and outer body. A first member is between the centre shaft and the cage for communicating movement therebetween, and a second member is between the cage and the outer body for communicating movement therebetween. Upon rotation of one said component (shaft, cage or outer housing) at least one of the remaining components is caused to rotate. The output from one component (shaft, cage, or outer housing) is such that variation of a load between zero and a maximum value corresponds to variation of the ratio of the angular velocity between the other two or more components. This variation is achieved by a second input or braking effect.

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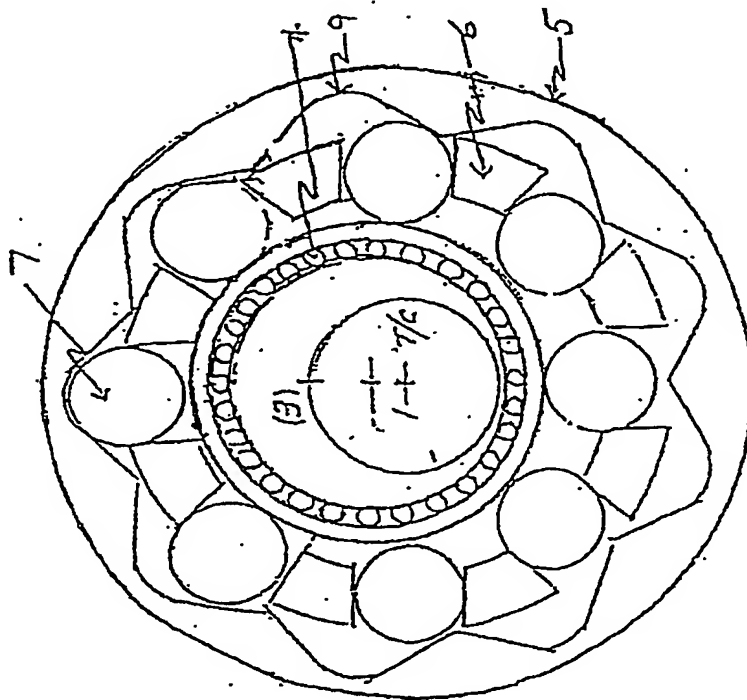


Fig 1.

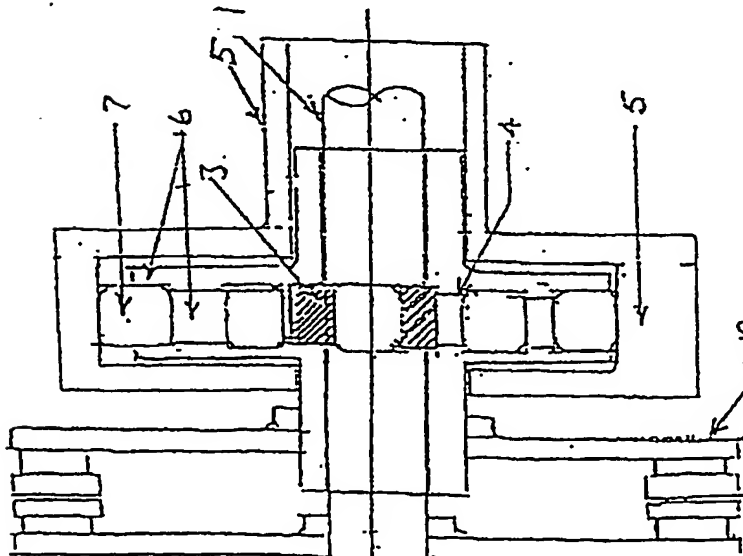
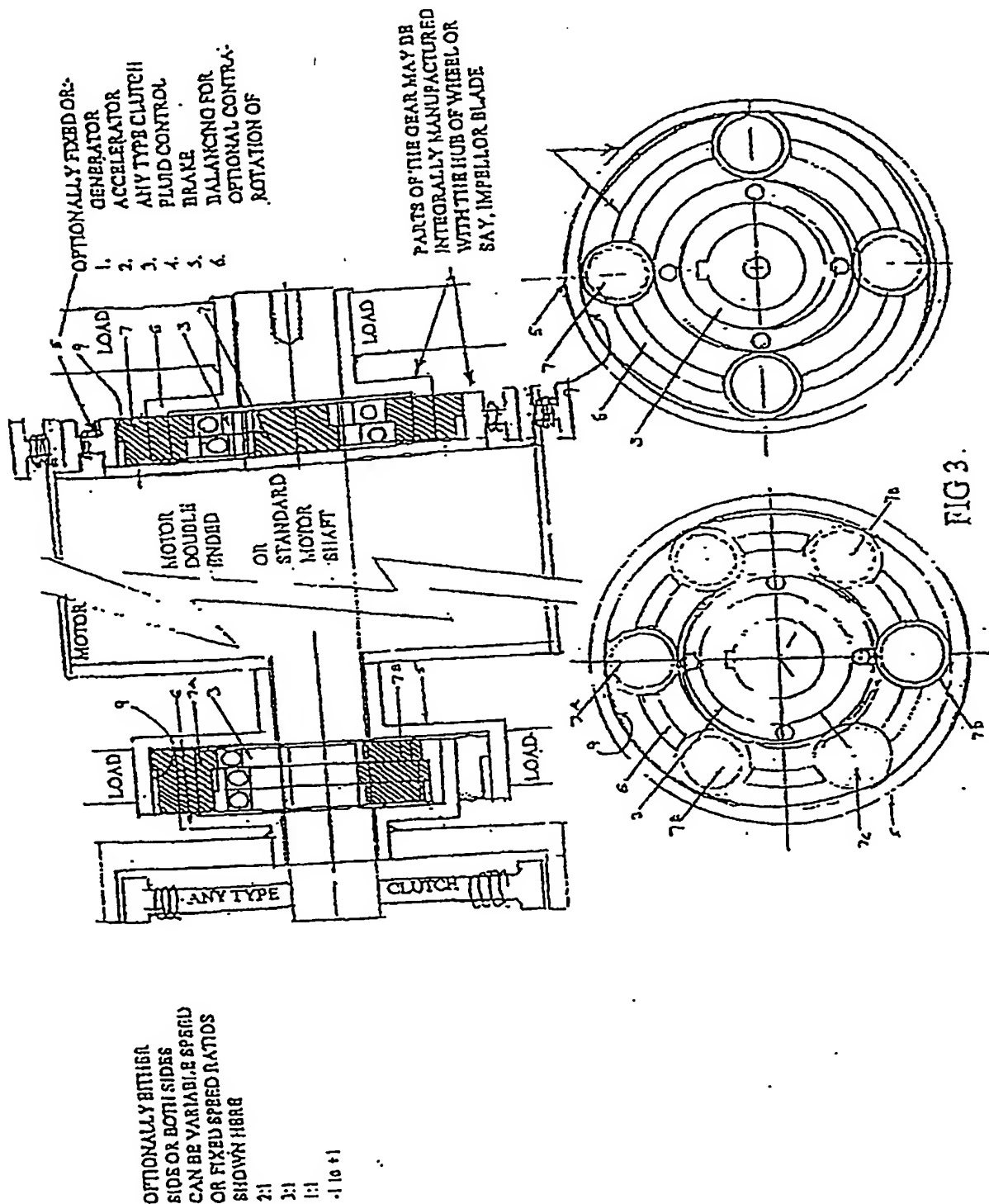


Fig 2.

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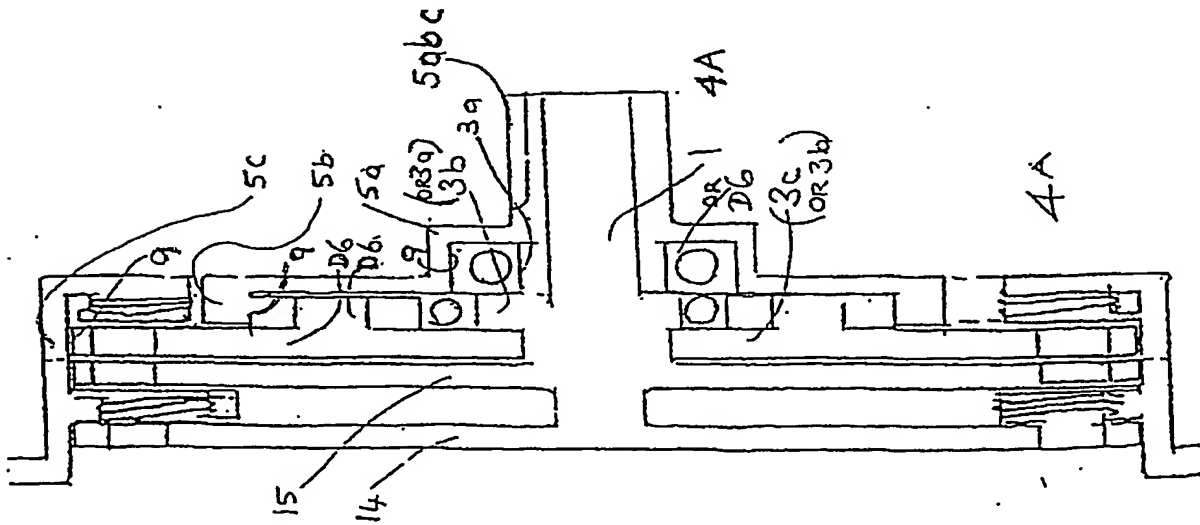
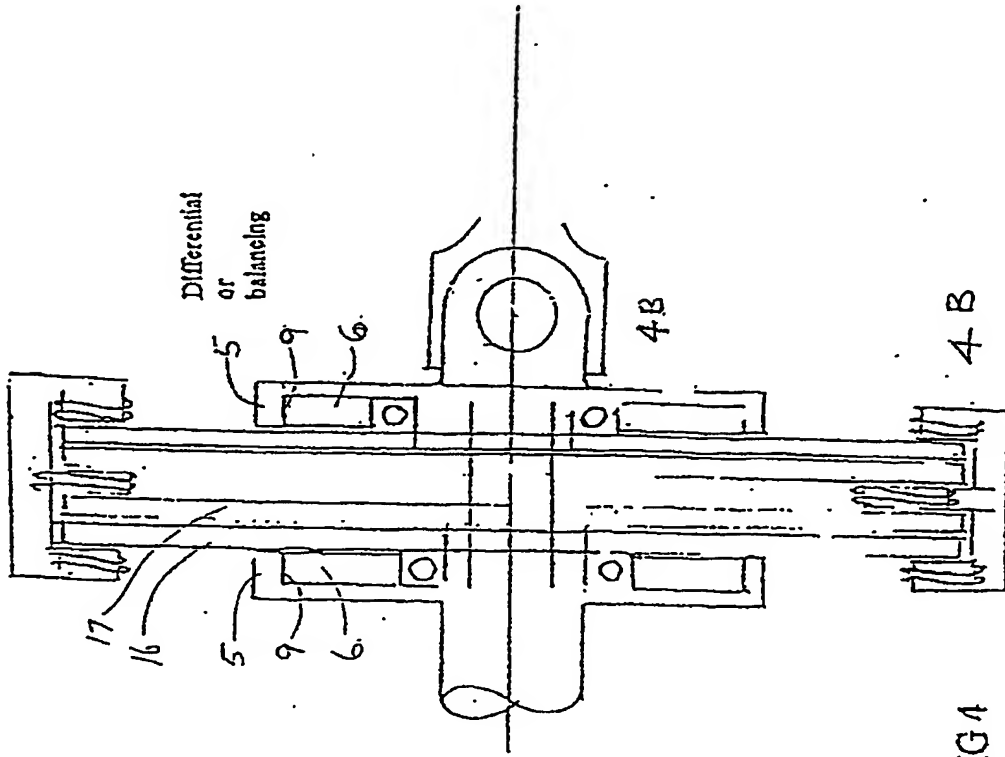


FIG 1



Differential
or
balancing



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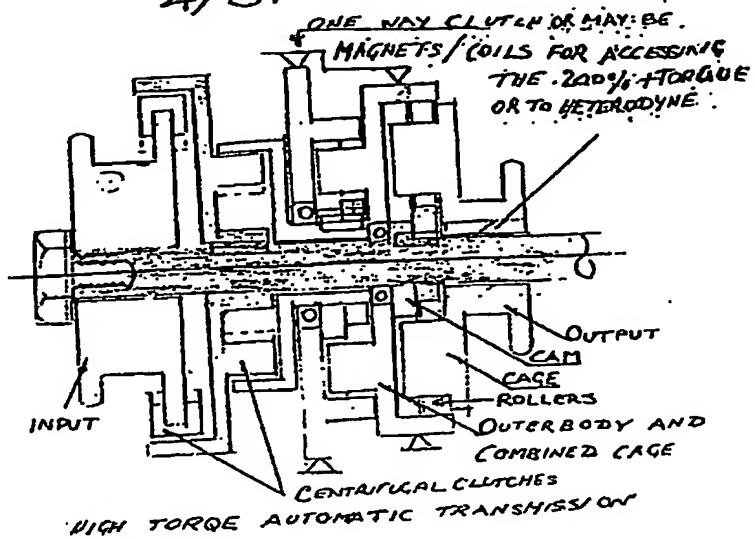
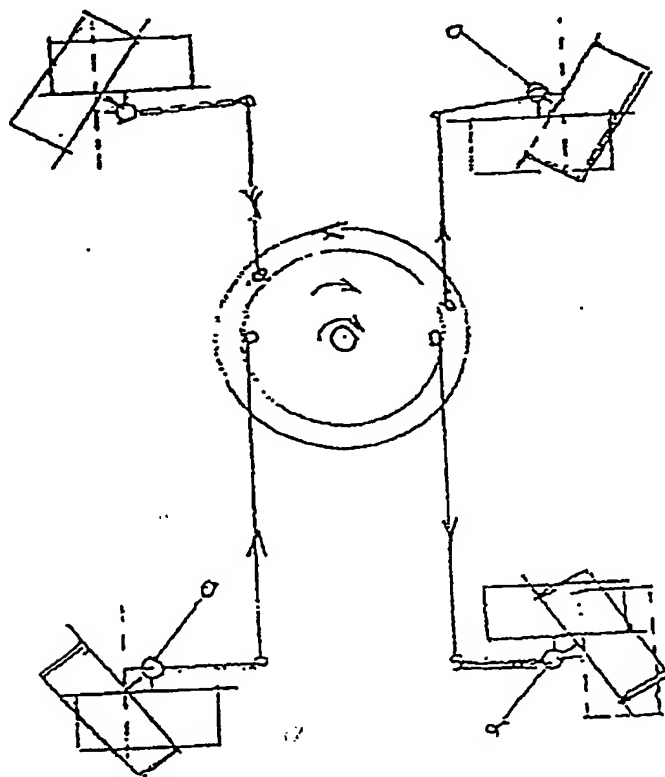


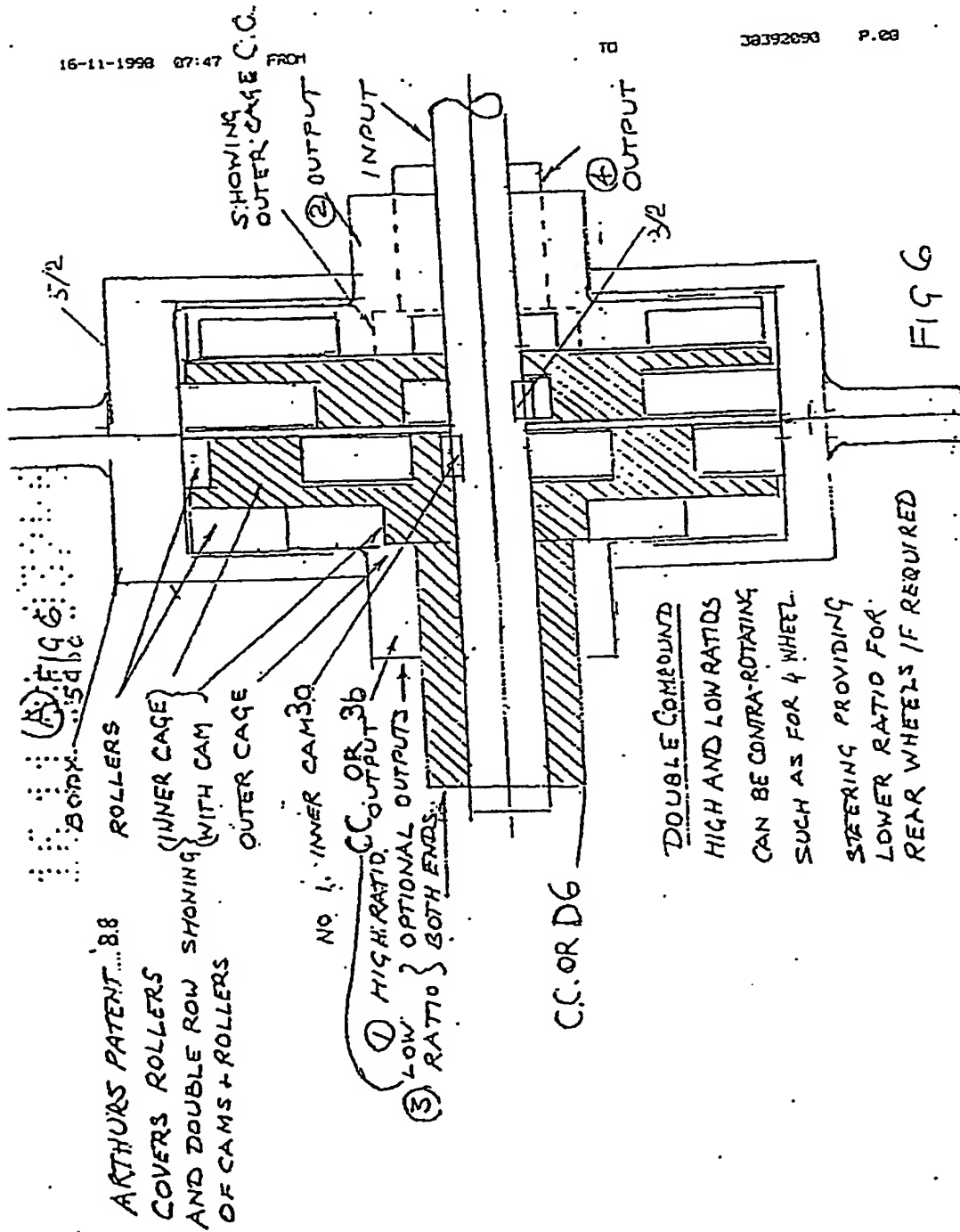
FIG 5

SHOWING HETERODYNING
ON OLD MECHANICAL DESIGN

FIG 5



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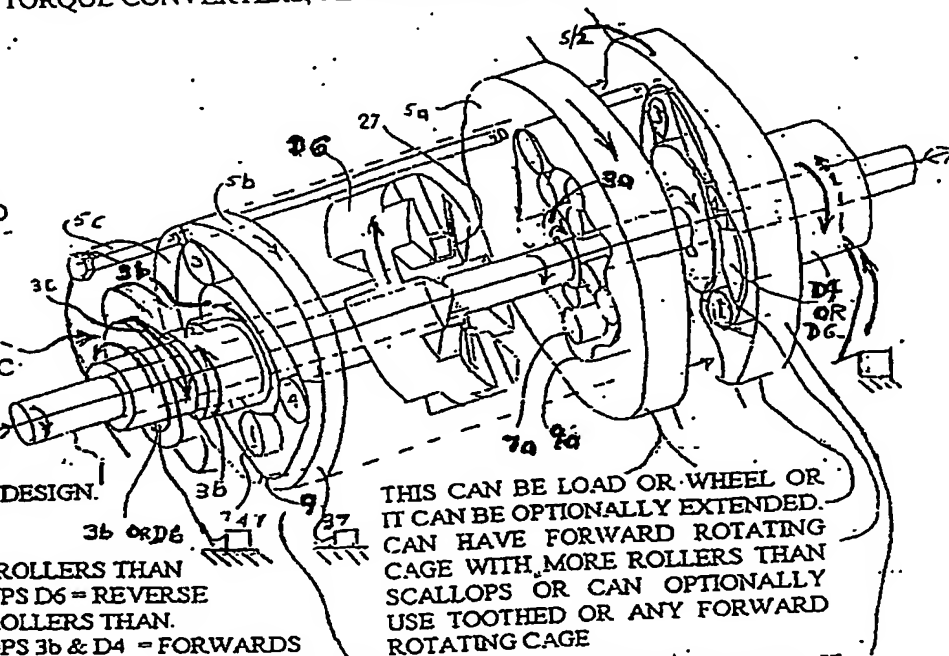
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VERY GREAT ADVANCEMENTS ON TRANSMISSIONS TOTALLY REVOLUTIONISING THEM, FOR EXAMPLE, PATENTS EP 0 794 360 A1 AND PATENT AU-B-74784/91 CAN BE FREE TO ROTATE, AND WORK DYNAMICALLY FOR EXAMPLE AS GEARED TORQUE CONVERTERS, ALL INSIDE ONE BODY.

FIG 6A
RATIOS WOULD HAVE TO BE CALCULATED ON DIFFERENT DESIGNS, AS ALSO FOR REVERSE TO WORK FROM BOTH ENDS. UNLIMITED CONCENTRIC LOW AND HIGH RATIO DYNAMIC EXTENSIONS ARE AVAILABLE FROM ANY PLANETARY GEAR DESIGN.

FEWER ROLLERS THAN SCALLOPS D6 = REVERSE
MORE ROLLERS THAN SCALLOPS 3b & D4 = FORWARDS

UNLIMITED COMBINATION ARE AVAILABLE FOR ANY TYPE OF PLANETARY GEAR, ie BOTH END RING GEAR, BODIES CAN BE THE SAME ie. CAN HAVE 3 SCALLOPS AND 4 ROLLERS CAGE/PLANET CARRIER OR ie. WITH D6 BEING A COMBINED ROLLER CAGE AND TOOTHED PLANET CARRIER SO AS TO ALTERNATIVELY ACCEPT 3b AS A TOOTHED SUN-GEAR REQUIRING A TOOTHED PLANETARY RING GEAR (CROWN). FOR PROVIDING A FIRST TORQUE FOR THE TRANSMISSION, THE ONE WAY BRAKING CLUTCH TO GROUND CAN BE COUPLED TO THE RING GEAR, (OR PLANET CARRIER OR 3b) IF THE LOAD IS TAKEN FROM D4. OR THE ONE WAY CLUTCH CAN BE COUPLED TO CARRIER D6 OR ANY HIGH RATIO CAM ie TO 3b. IF THE LOAD IS TAKEN FROM THE BODY. THE ONE WAY CLUTCHES CAN BE CONTROLLABLE, RELEASABLE, REVERSABLE, AUTOMATIC, OR MANUAL. THE NUMBER OF THE ROLLERS IN 5a ARE ALSO VARIABLE AN EXAMPLE IS 5 SCALLOPS AND 4 ROLLERS



THIS CAN BE LOAD OR WHEEL OR IT CAN BE OPTIONALLY EXTENDED. CAN HAVE FORWARD ROTATING CAGE WITH MORE ROLLERS THAN SCALLOPS OR CAN OPTIONALLY USE TOOTHED OR ANY FORWARD ROTATING CAGE

OPTIONAL RELATIVE NUMBERS OF ROLLERS AND SCALLOPS

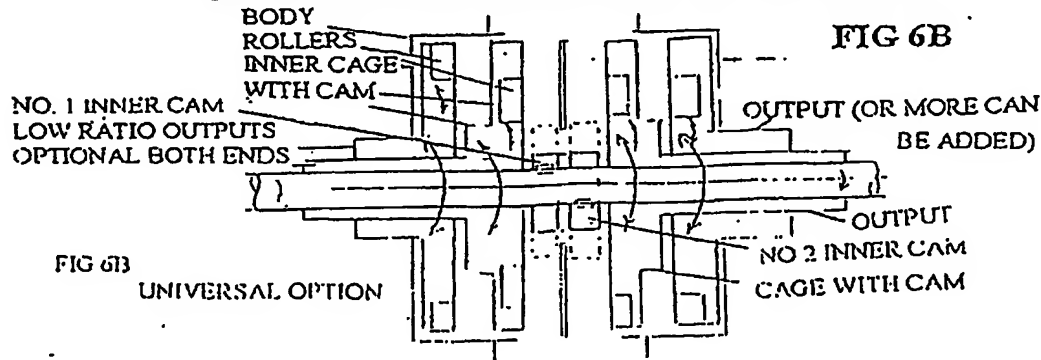


FIG 6B
UNIVERSAL OPTION

FIG 6B

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(3/4) FORWARD
 (5/4) REVERSE
 (3/4) FORWARD
 (5/4) REVERSE
 3, ANY C. (PSEI - RIN/05)
 ONE MORE ONE LESS

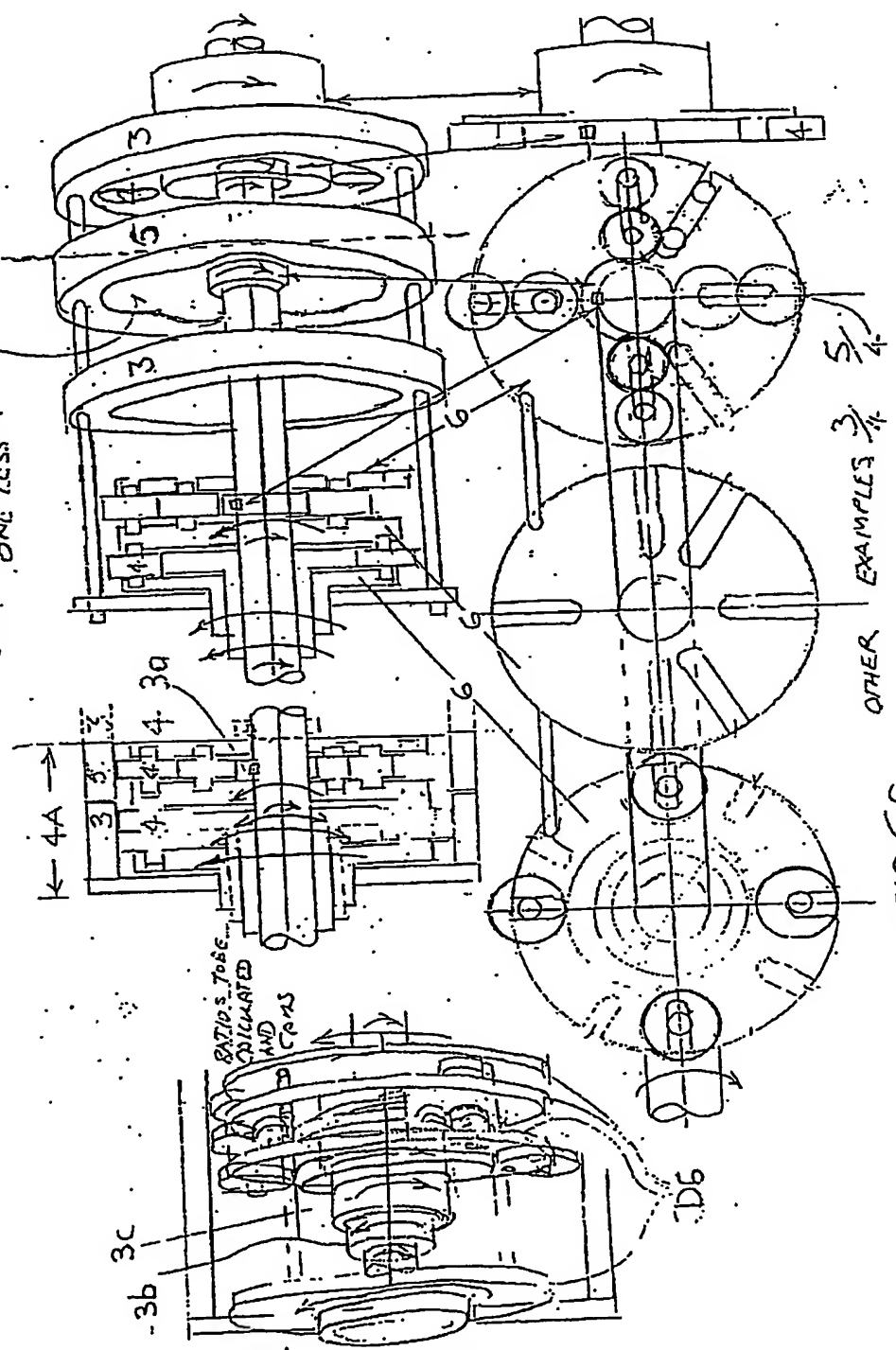


FIG 6C

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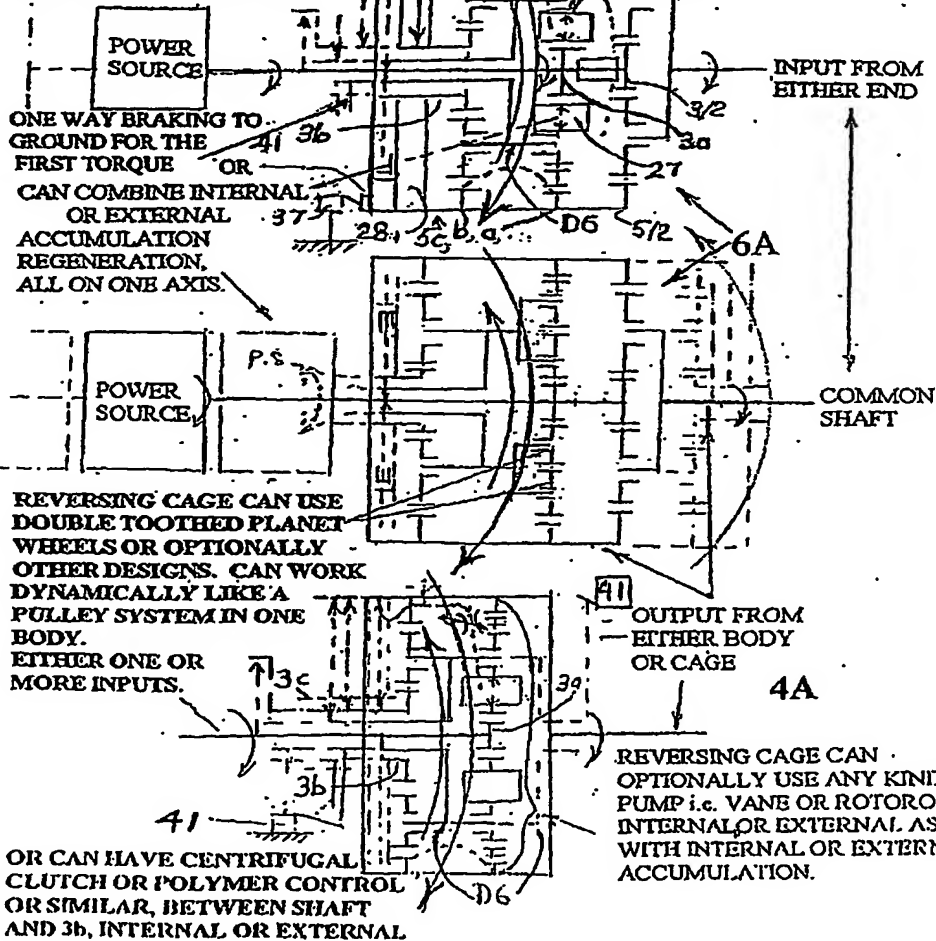
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FIG 6 D

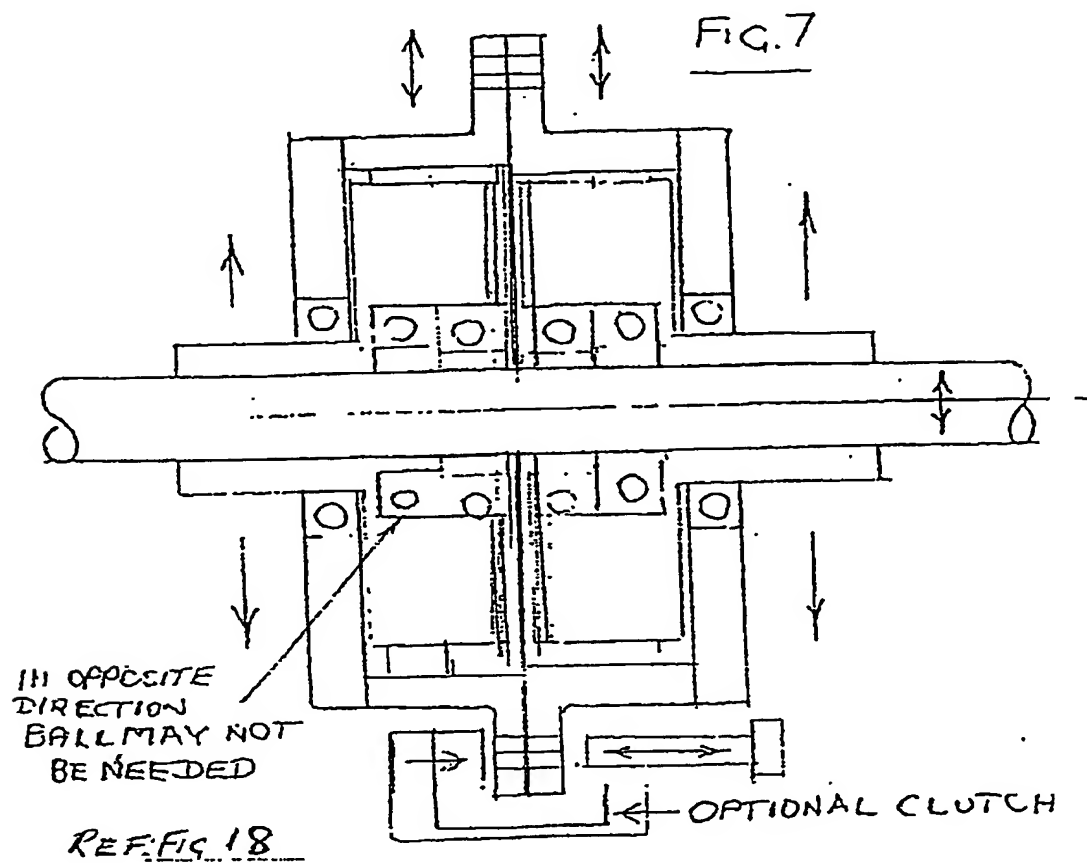
CAN OPTIONALLY USE TOOTHED GEARING WITH CROWN WHEEL ON EITHER SIDE. REVERSING CAGE D6 CAN BE COUPLED TO A PLANET CARRIER IN ORDER TO USE A PLANET WHEEL (OR SUN-GEAR) 3b. NEEDS NO RELATIVE FRAME, CAN SUIT ANY HIGH SPEEDS. CAN BE GEARED TORQUE CONVERTER.

CENTRIFUGAL SPEED CONTROL, i.e. GOVERNOR CAN HAVE i.e. VANE PUMP BETWEEN REVERSING CAGE AND NO. 1 INNER CAM PUMPING HIGH RATIO CAM OR COMPONENT AGAINST THE BODY FOR CONTROL/GOVERNING ie DISPLACEMENT BETWEEN ROLLERS AND SCALLOPS

SEE WHEELS WITHIN WHEELS 1996



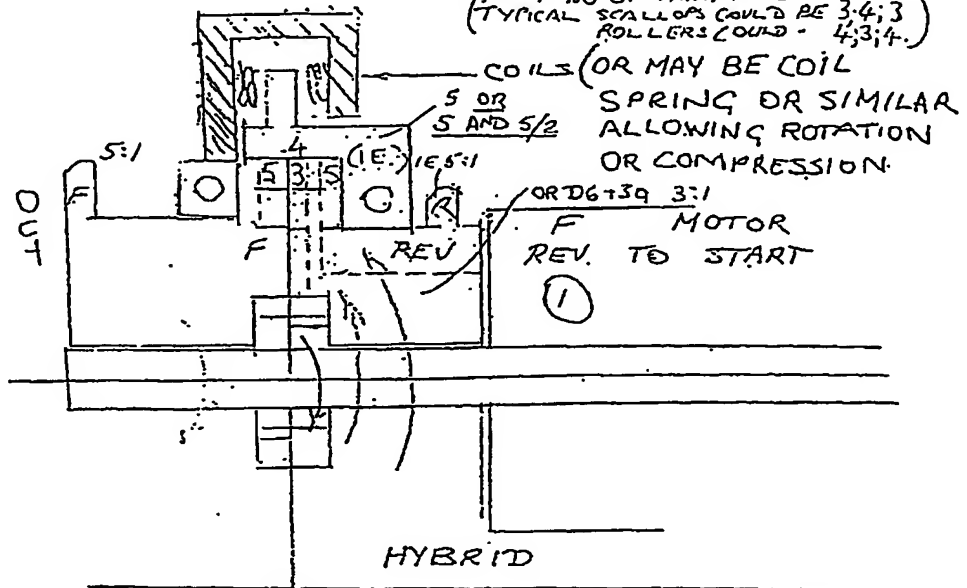
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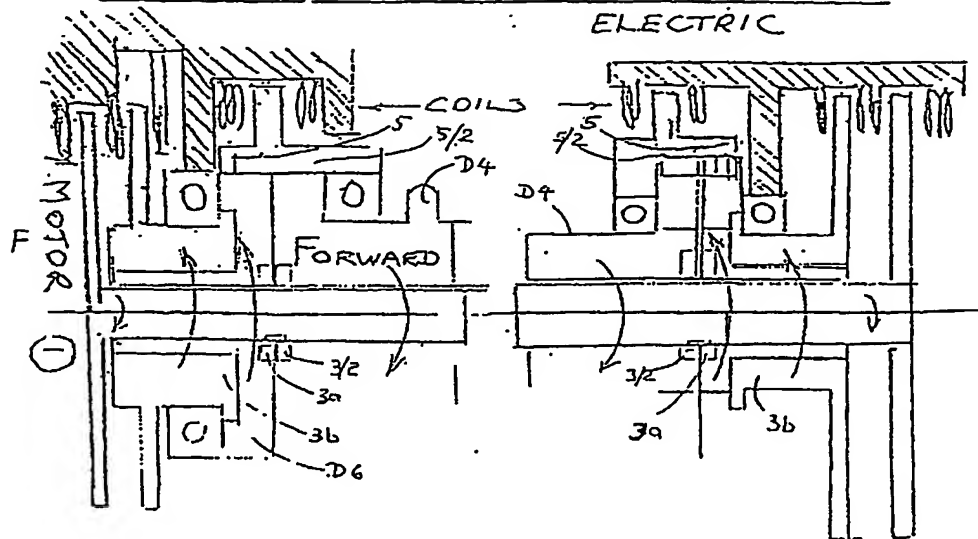
10/31.

FIG 8 B

(ANY NO OF VARIATIONS
TYPICAL SCALLOPS COULD BE 3:4;3
ROLLERS COULD - 4;3;4.)

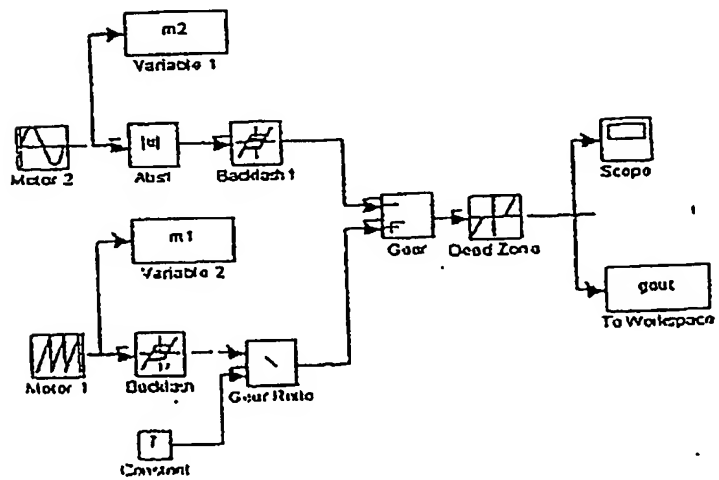
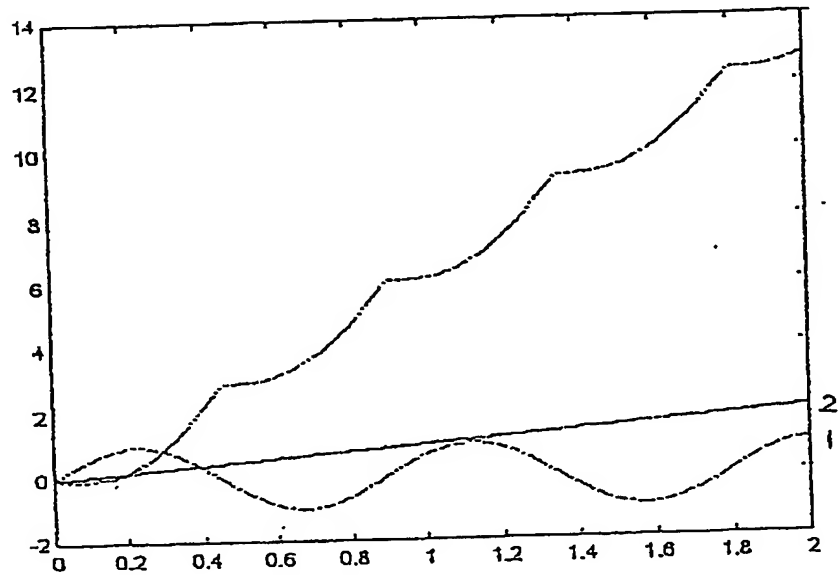


ELECTRIC



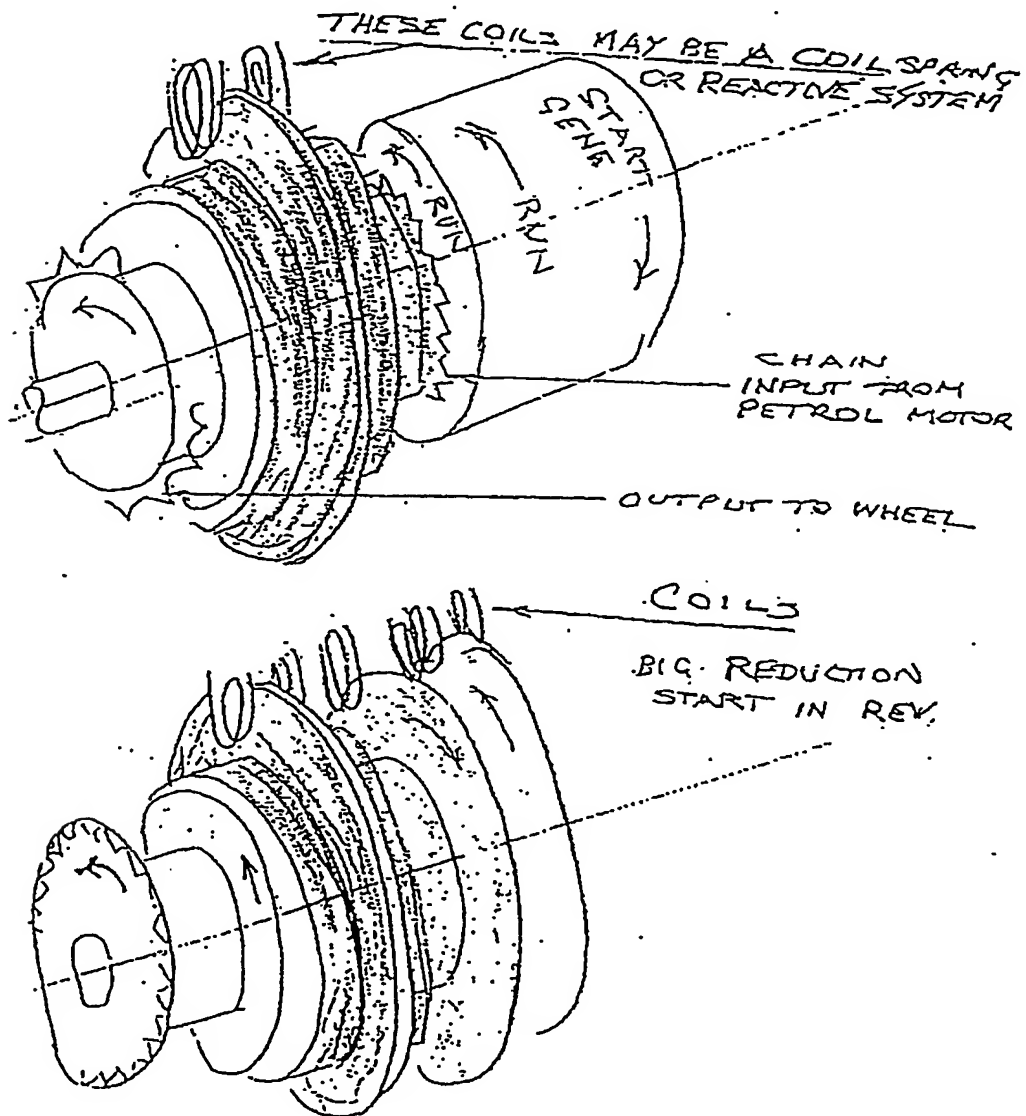
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FIG 9.

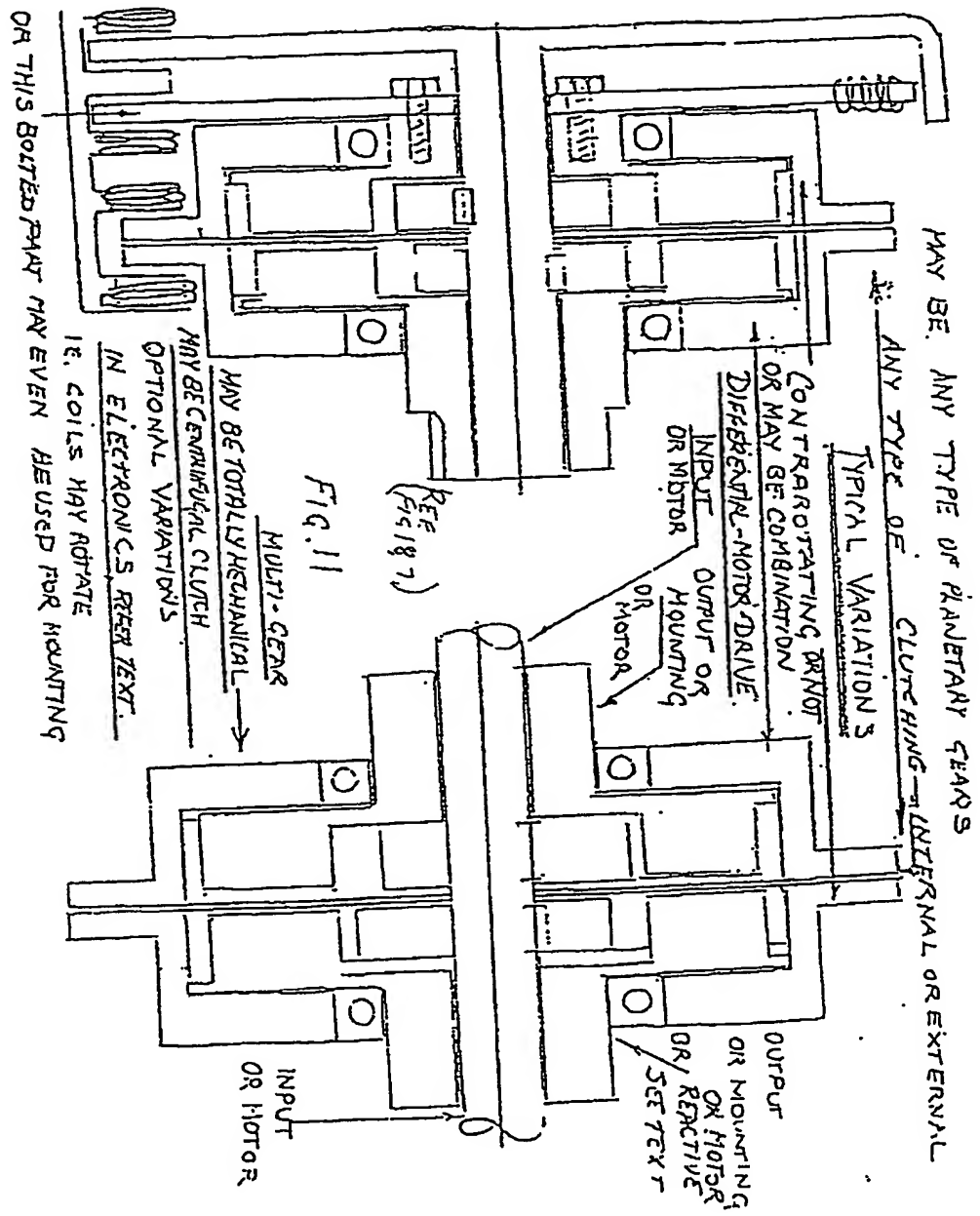


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FIG 10



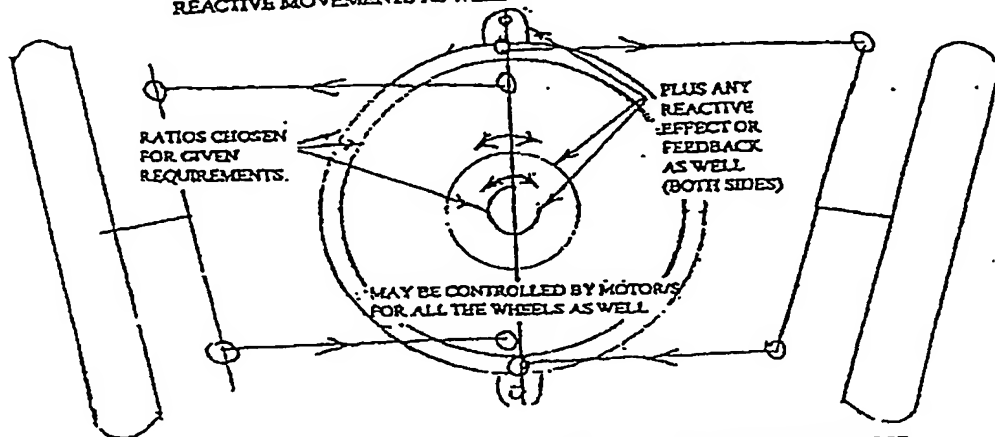
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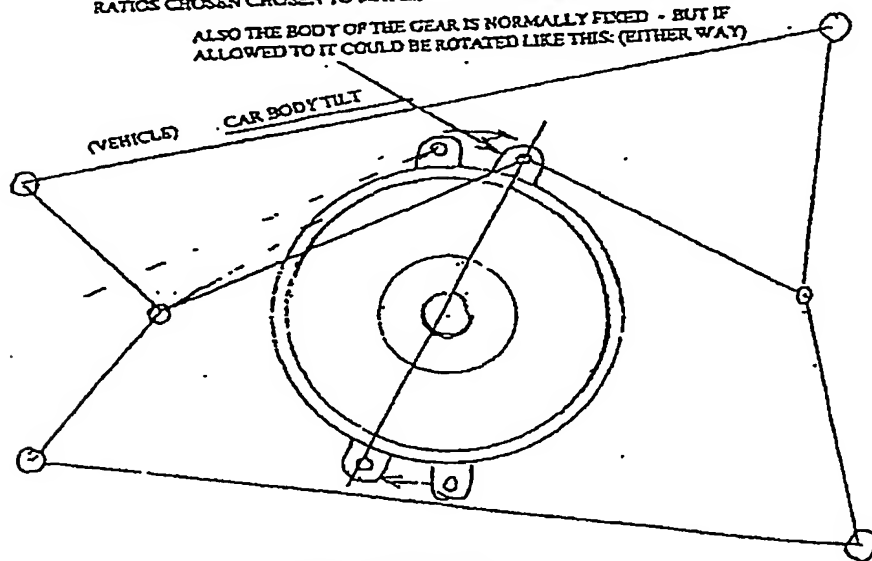
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FIG 12

LIKE RIDING A MOTORCYCLE
ANY MOBILE ON LAND, SEA OR AIR, CAN PROVIDE PASSENGERS OR CARGO
THIS TILTING CAN BE DONE WITHOUT THE GEAR, HOWEVER THE DOUBLE
CONTRA-ROTATION CAN PROVIDE CONTINUOUS CORRECTION OR OTHER
REACTIVE MOVEMENTS AS WELL

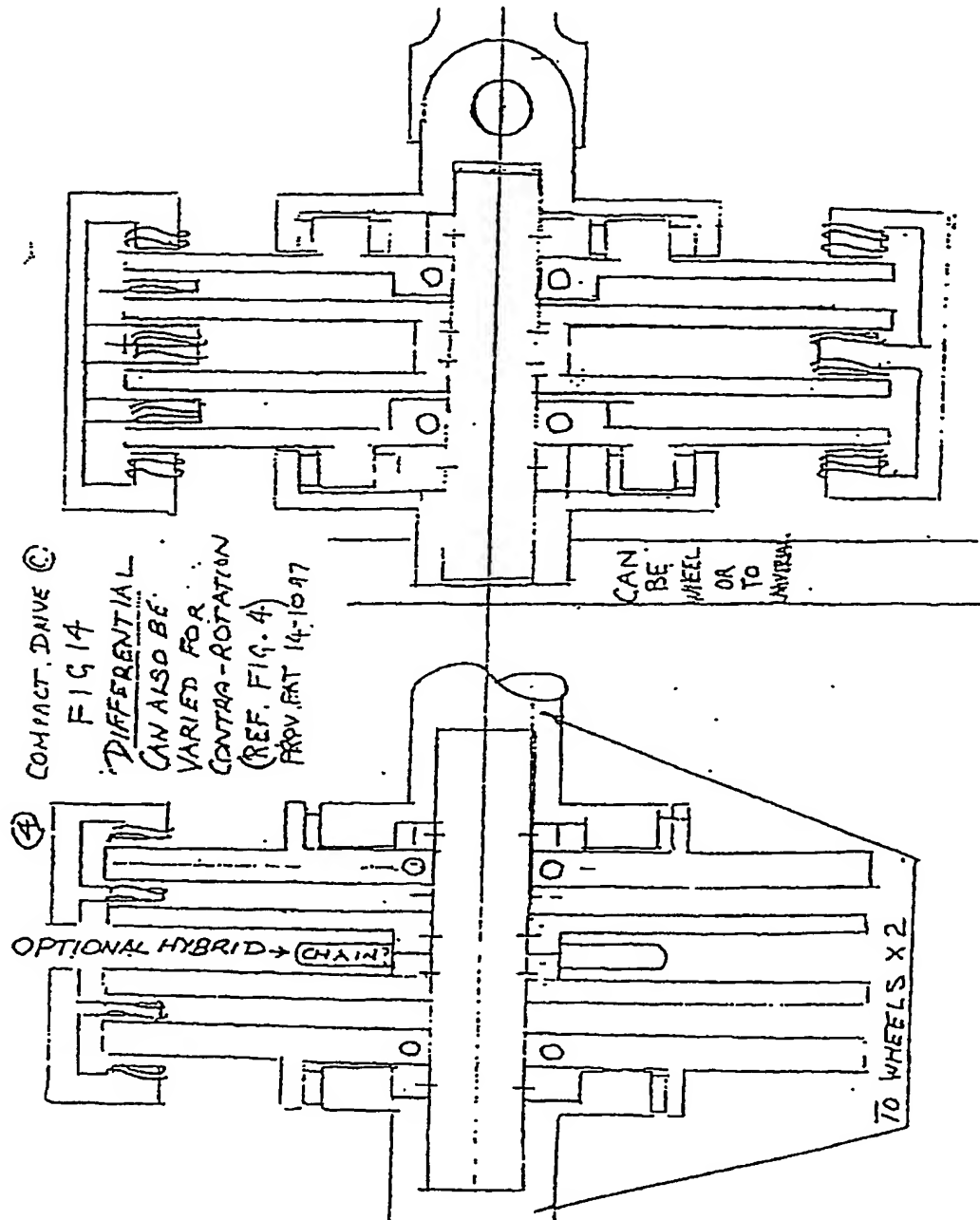


RATIOS CHOSEN CHOSEN TO MATCH THE FEEDBACK WITH THE FORCE REQUIRED
ALSO THE BODY OF THE GEAR IS NORMALLY FIXED - BUT IF
ALLOWED TO IT COULD BE ROTATED LIKE THIS: (EITHER WAY)

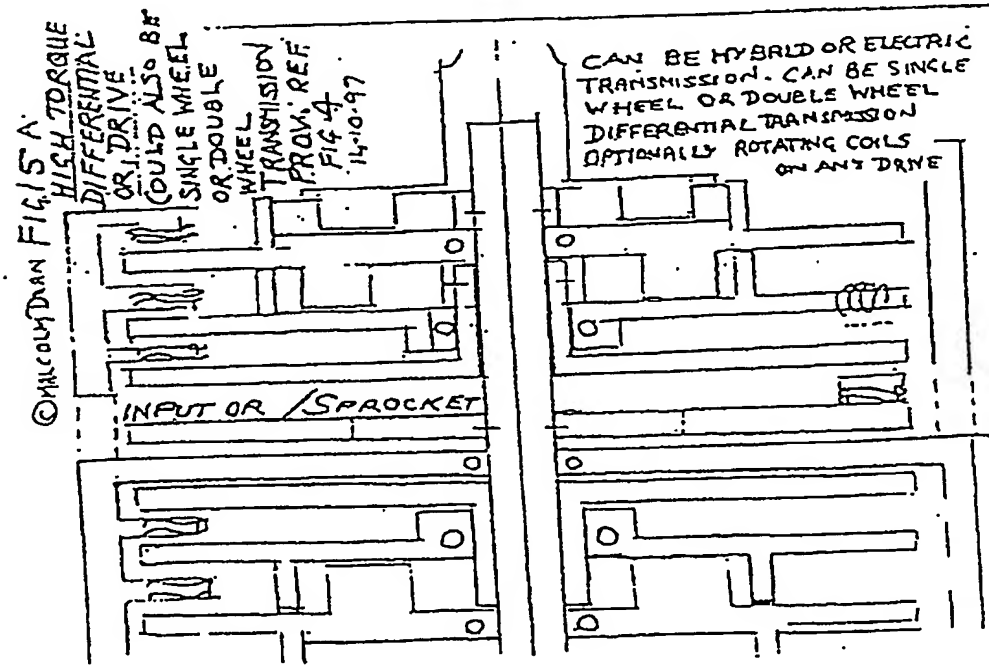
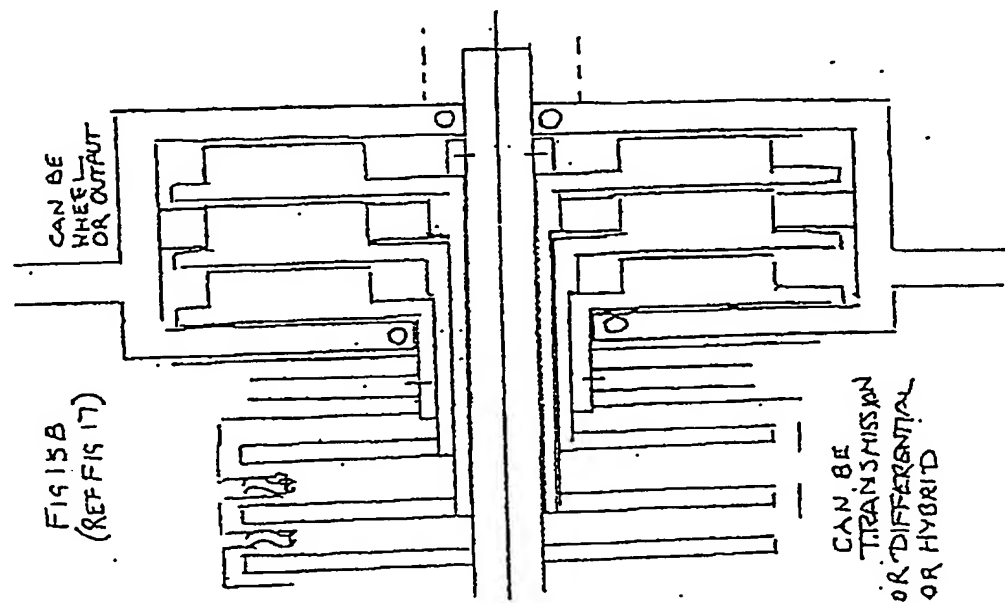


CAN ALSO BE COMBINED WITH
FIG 3 STEERING GEAR TO CORRECT
CASTER AS WELL

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FIG 16 B
REF. FIG. 3, 4, 6.

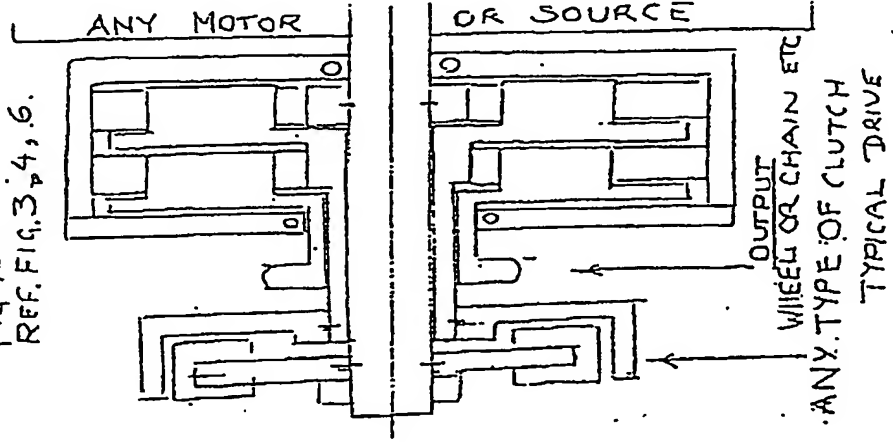
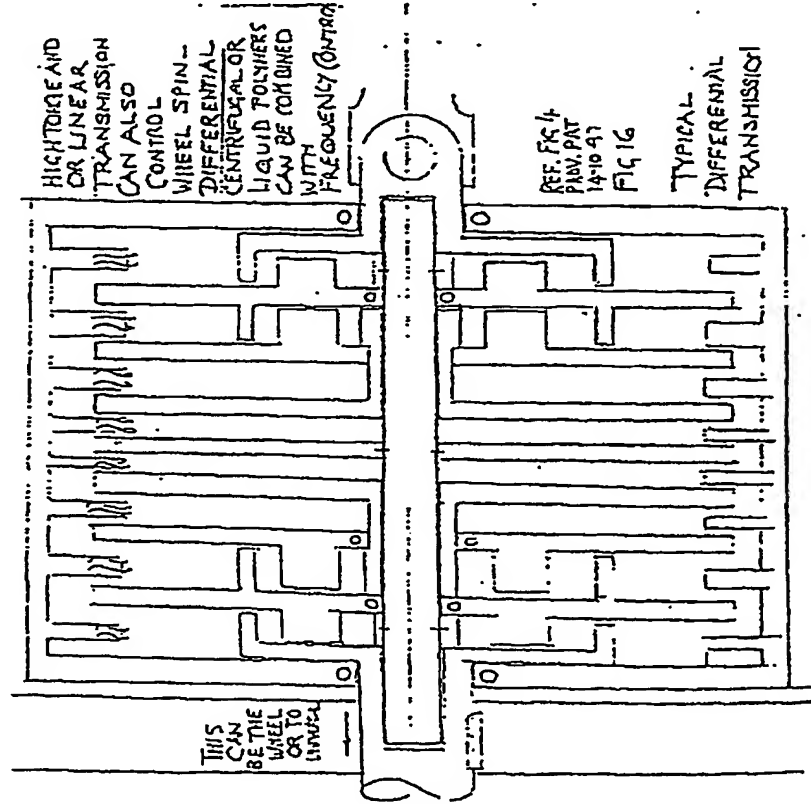
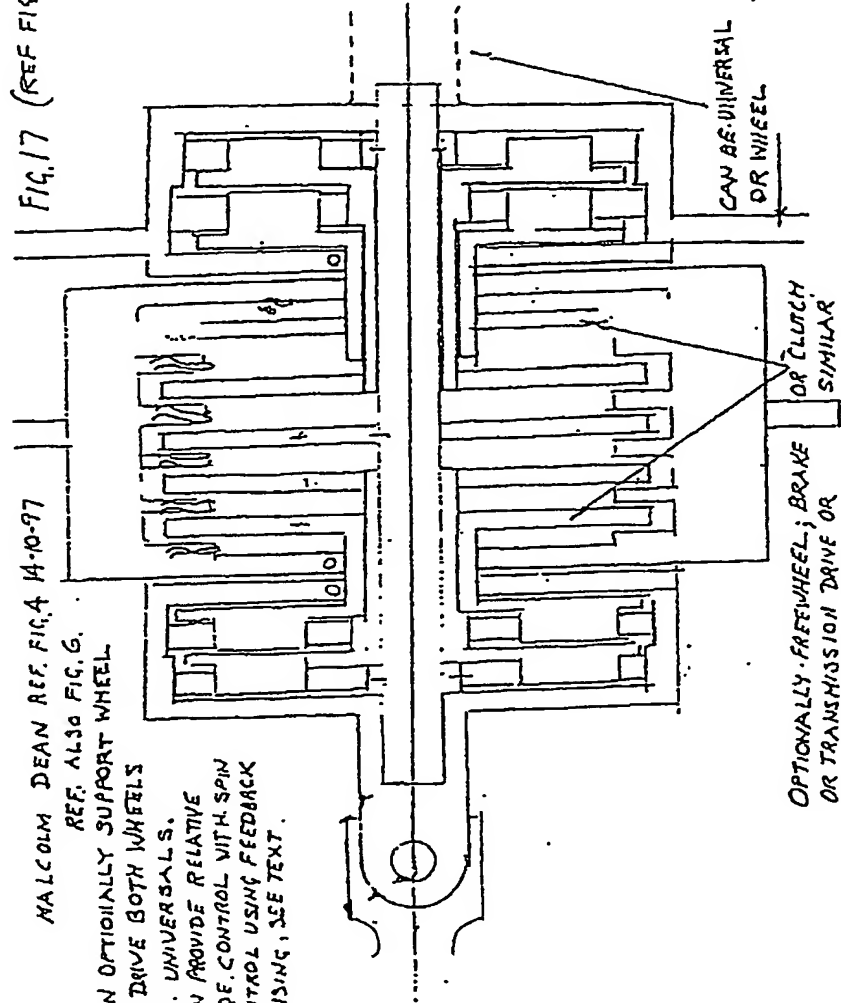


FIG 16 A



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FIG. 17 (REF FIG 15B)



MALCOLM DEAN REF. FIG. 4 14-10-97

REF. ALSO FIG. 6.

CAN OPTIONALLY SUPPORT WHEEL
OR DRIVE BOTH WHEELS
VIA UNIVERSALS.
CAN PROVIDE RELATIVE
TORQUE CONTROL WITH SPIN
CONTROL USING FEEDBACK
SENSING, SEE TEXT.

CAN BE UNIVERSAL
OR WHEEL

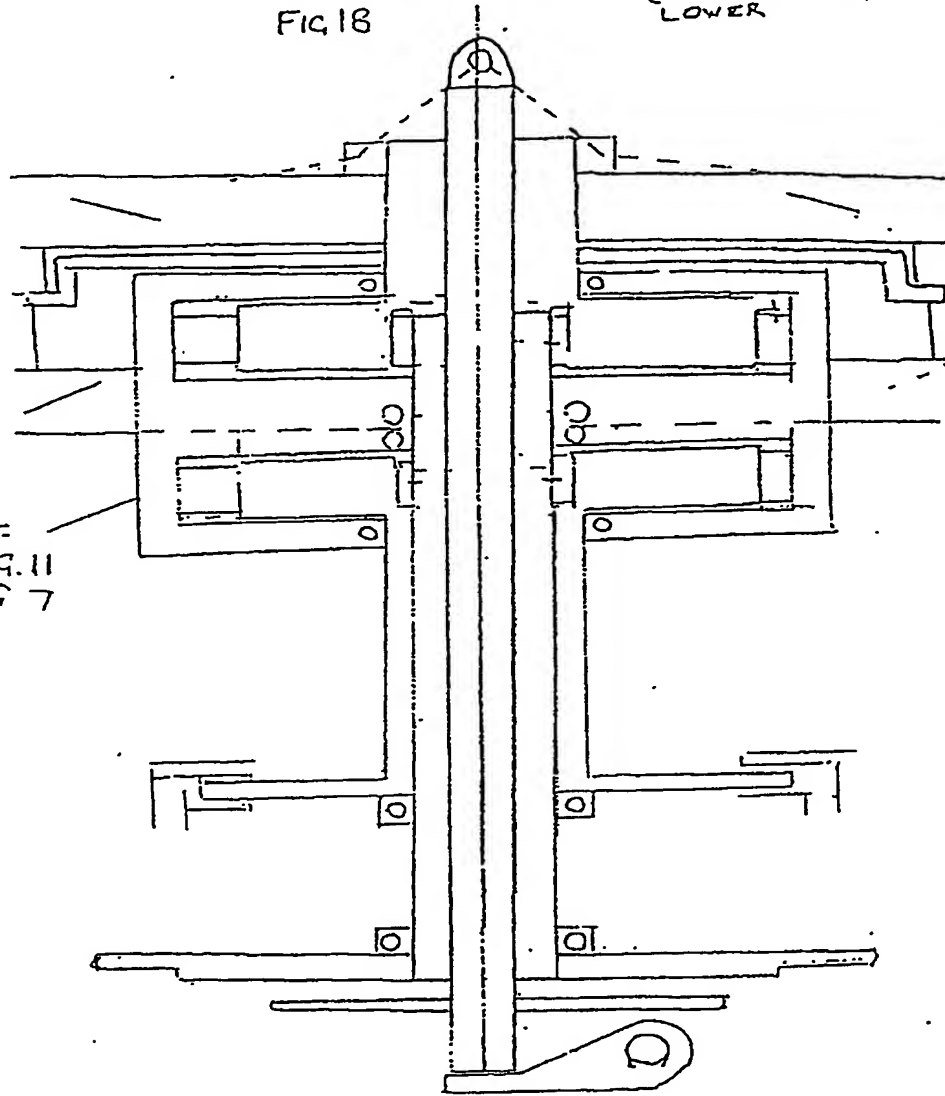
OPTIONALLY FREEWHEEL, BRAKE
OR TRANSMISSION DRIVE OR
OR CLUTCH OR SIMILAR

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FIG 18

SWASH ACTION
CONTRAROTATING
LOWER

REF
FIG. 11
FIG 7



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 SHOWING HETERODYNING
 ON OLD MECHANICAL DESIGN

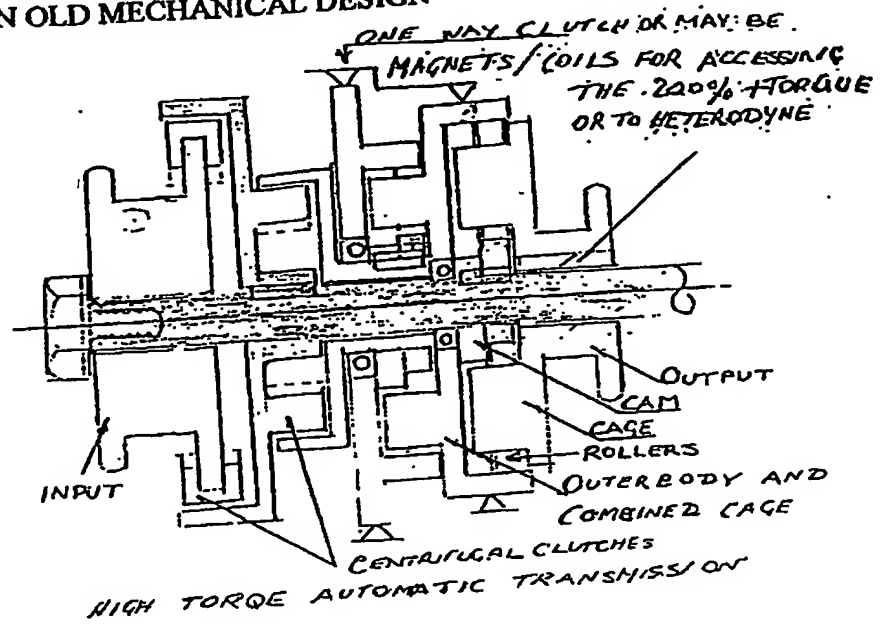


FIG 5

SEE "WHEELS W.W." 3-6-COMPRESSORS

HYDRAULIC PROV 2 L19; 13-20
HYBRID " 10 12-13; 4-17-25; 15-1 POLYMERS

P3-25 1-23

P 4-17 HYDR 13-20 15-2

4-21 HYBRID 10-12 13

FILINGS 15-13

POLYMERS 15-16

HYD MOLECULAR 22-11

INTEGRATE 25-6

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BUILT IN FEATURES -
GEARING; MULTIPLICATION;
ACCUMULATORS; COMPRESSORS
ROTARY COMBUSTION ENGINES

THE ABILITY TO TOTALLY
ENCLOSE TRANSMISSIONS
OPTIONALLY, WITH ALL THE
HYBRID COMPONENTS, CAN BE
USED, ROTATING INTERNALLY

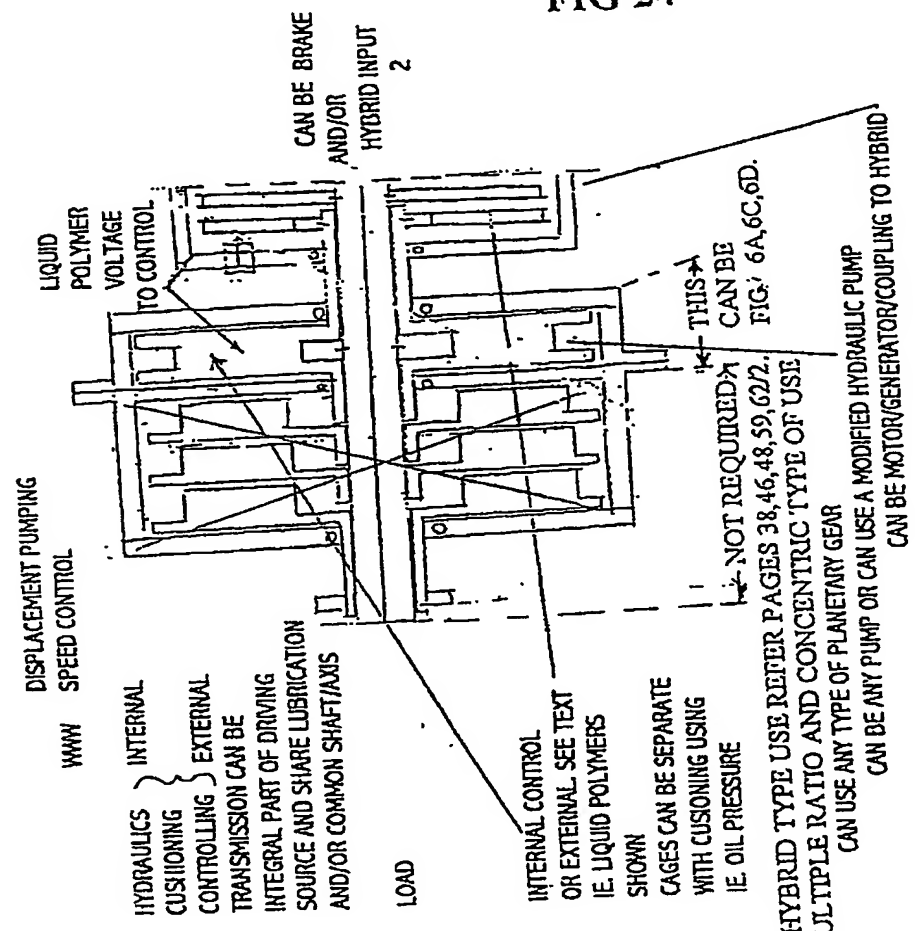
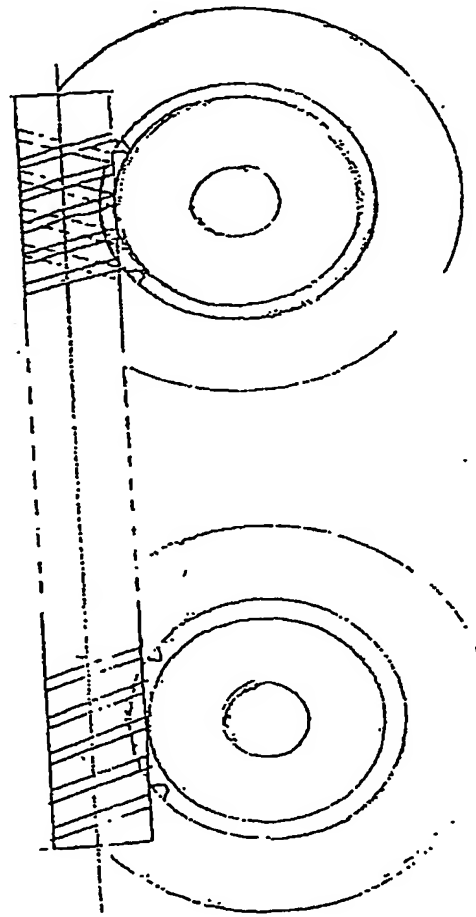


FIG 24

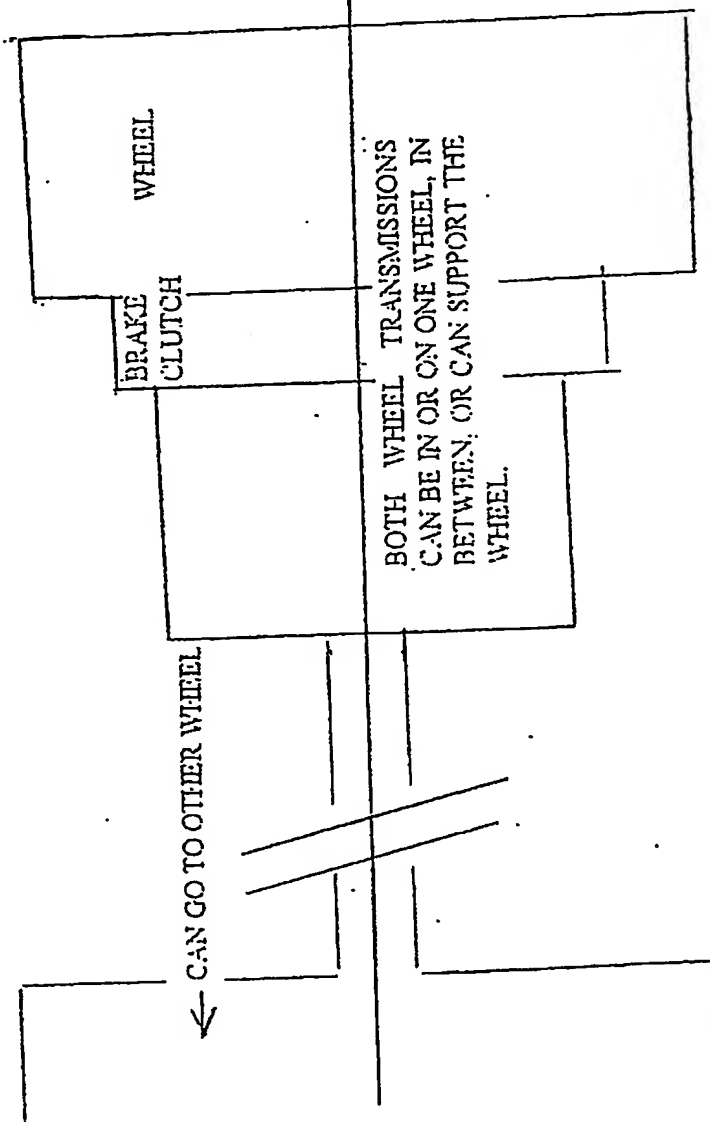
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FIG. 25

OPTIONALLY CAGE OR OUTER BODY/S CAN BE WORM (WORM WHEEL DRIVE)
DRIVING WHEELS BETWEEN AXLES



- 1 OPTIONAL HYDRAULIC CONTROL BY PORTING AND TIMING INTERNALLY
- 2 THESE HYDRAULIC VALVES CAN THEMSELVES BE SUBSTITUTED BY LIQUID POLYMERS, MAGNETIC OR SIMILAR CONTROL, INTERNALLY OR EXTERNALLY.

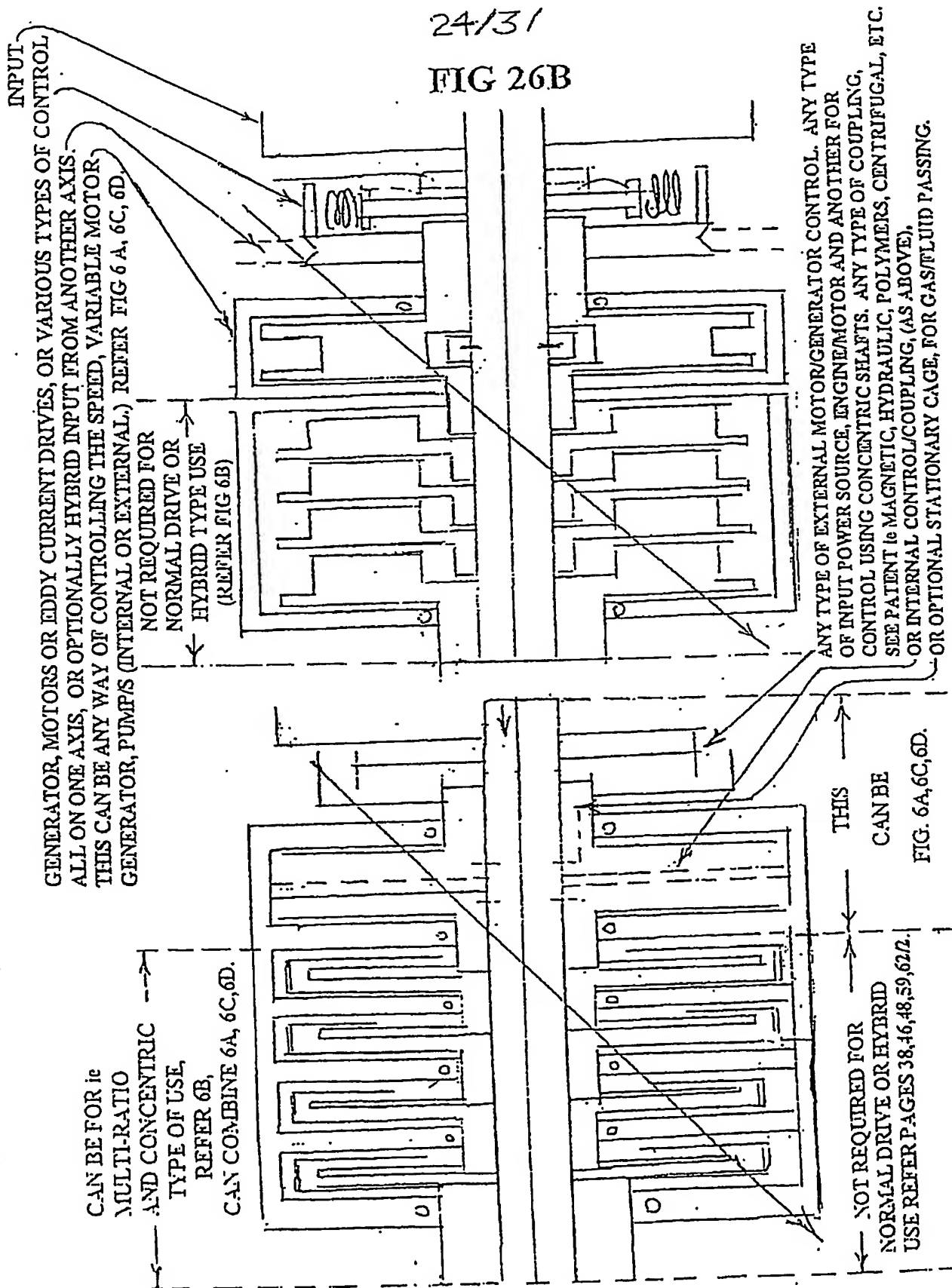


- 3 CAN INCLUDE COMPRESSOR/COMBUSTION MOTOR LAMINATED WITH GEARING.

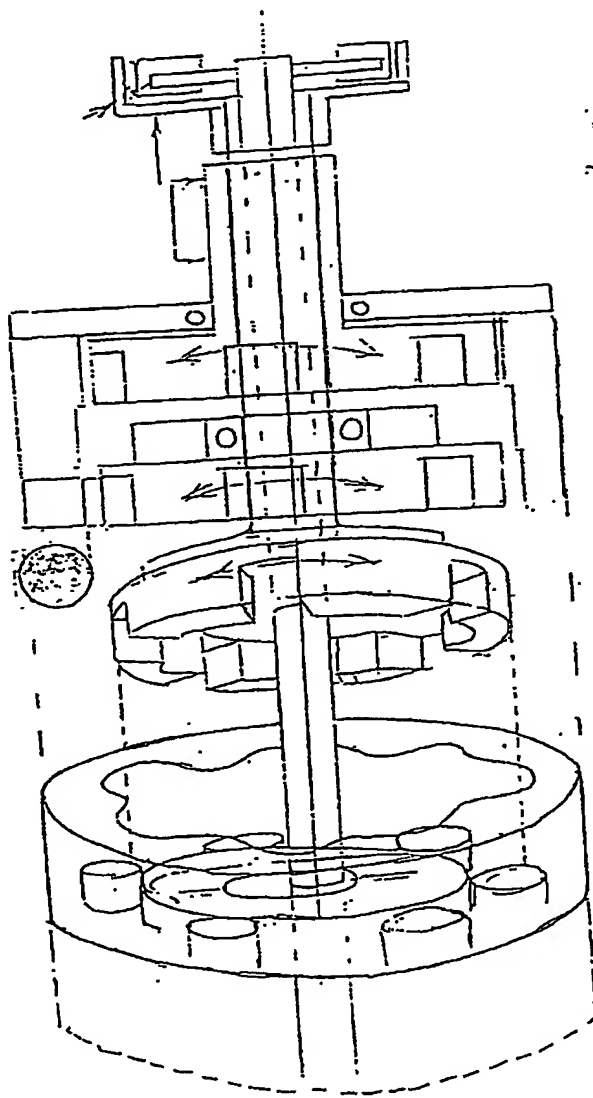
FIG 26A

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FIG 26B



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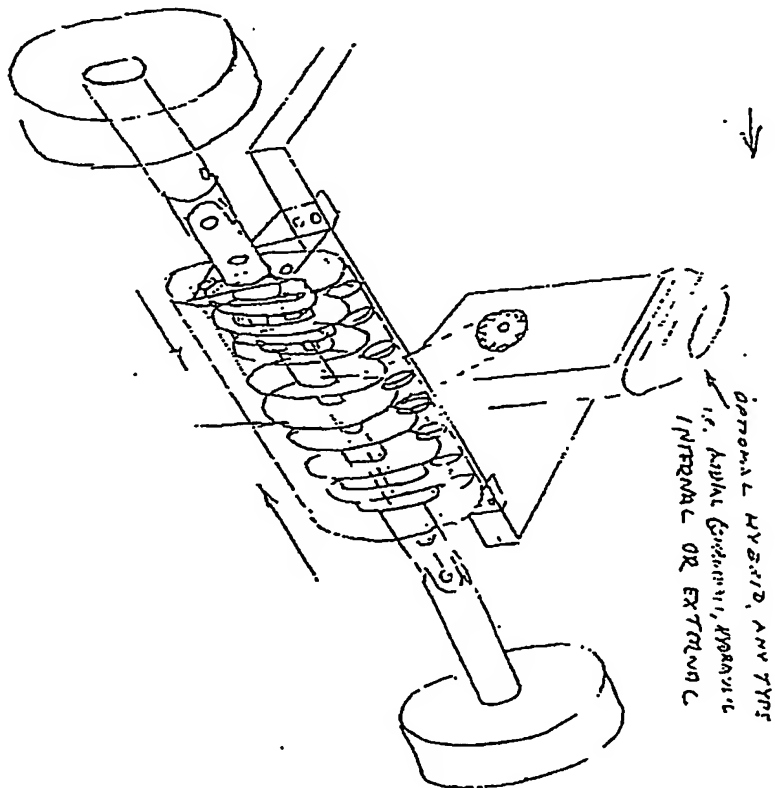
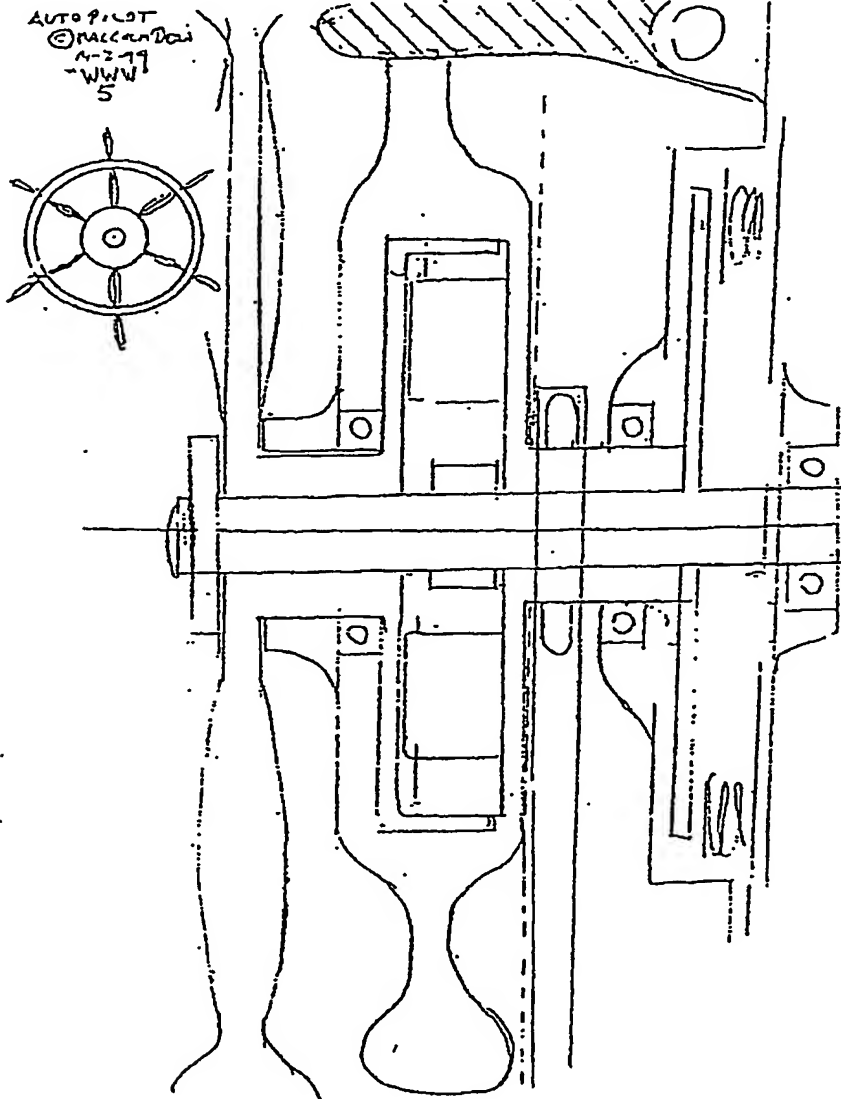


FIG. 27B

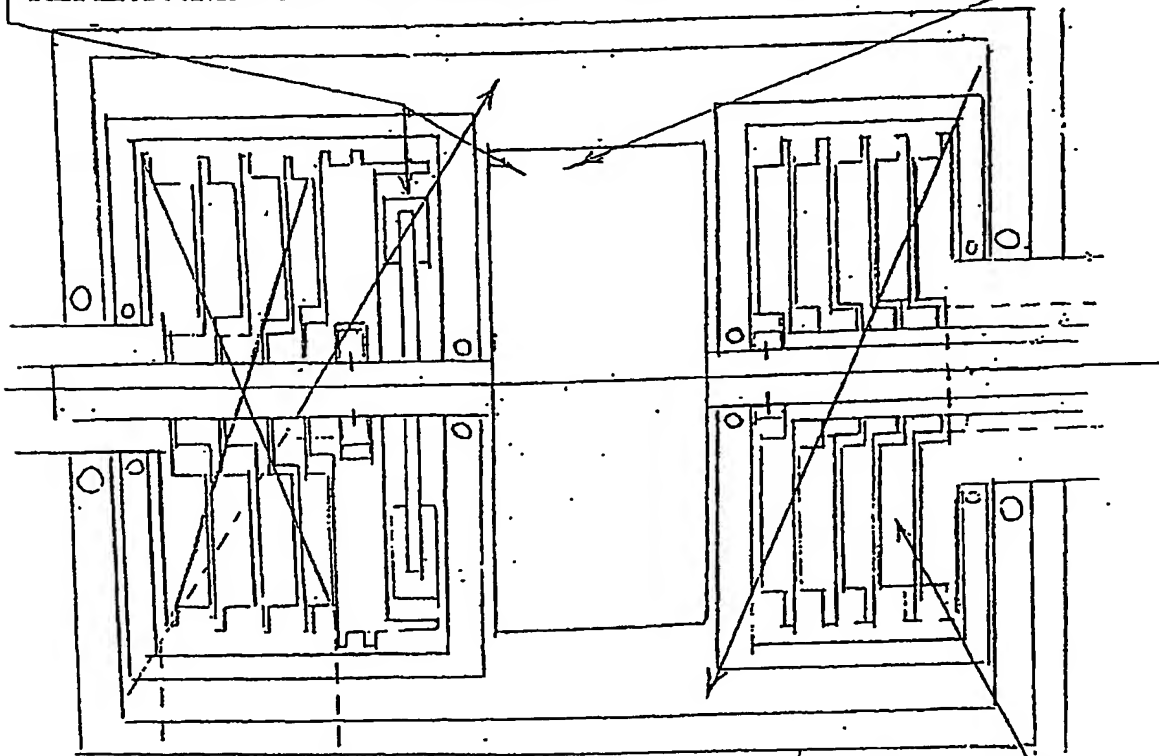
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FIG 28 A



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FIG 28B

CAN BE COMPLETE TWO WHEEL TRANSMISSION, POWER SOURCES
CAN BE COMBINED, ANY TYPE OF ROTARY ENGINES/MOTORS
ie HYDRAULIC, INTERNAL COMBUSTION, ELECTRIC WITH
INTERNAL OR EXTERNAL CLUTCHING/PUMPING SEE FIG 6D, 6A, 6C
CAN BE SHARING LUBRICATION, CAN BE FOR REGENERATION
ACCUMULATION, INTERNAL OR EXTERNAL, ALL ON ONE AXIS.
REFER PATENT AND PARTICULARLY PAGES ie 27, 29, 62, 63, 64.



NOT REQUIRED FOR
NORMAL DRIVE OR
HYBRID TYPE USE
REFER PATENT AND
PAGES 38, 46, 48, 59, 62/2

ie FIG, 6A, 6C, 6D.

FIG 6A, 6C, 6D.

ie MULTIRATIO
CONCENTRIC OPTIONS
REFER PATENT
AND FIG 6B

NOT REQUIRED FOR
NORMAL DRIVE OR
HYBRID TYPE USE
REFER PATENT AND
PAGES 38, 46, 48, 59, 62/2

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FIG. 29A

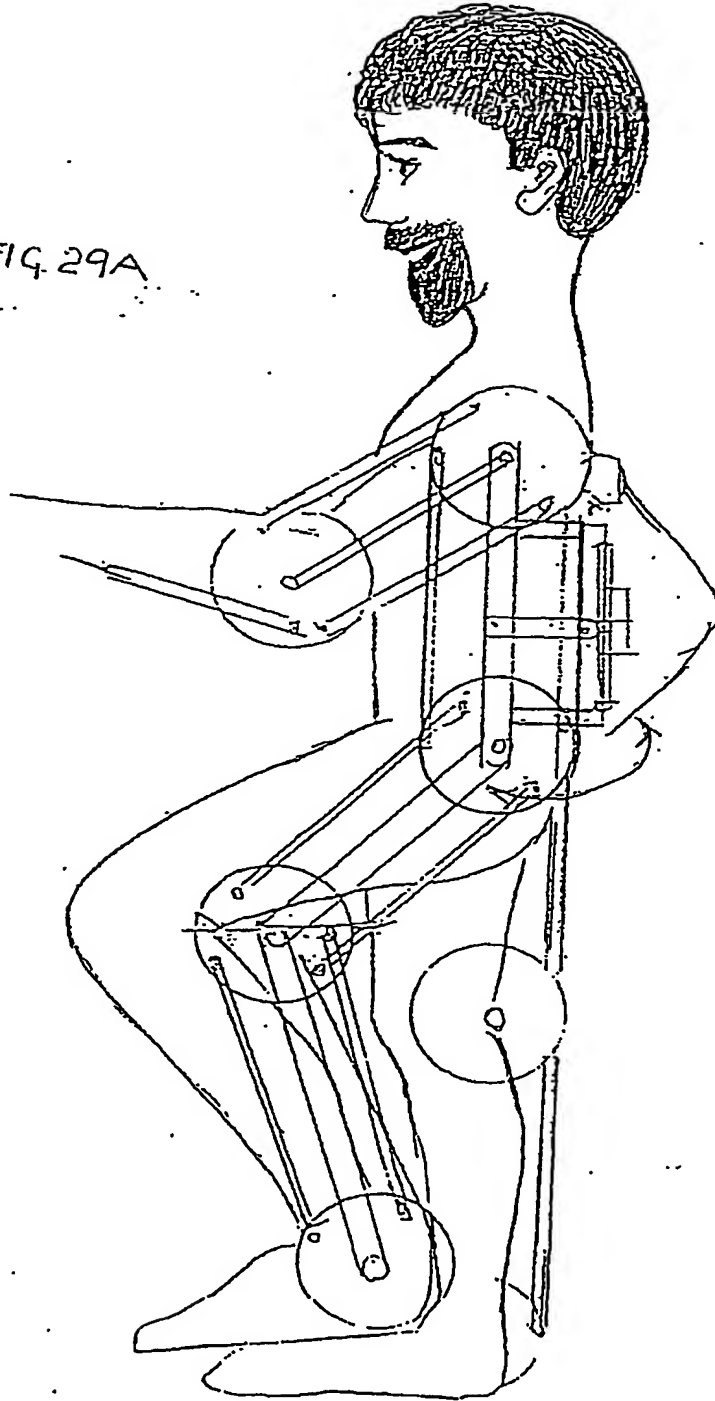
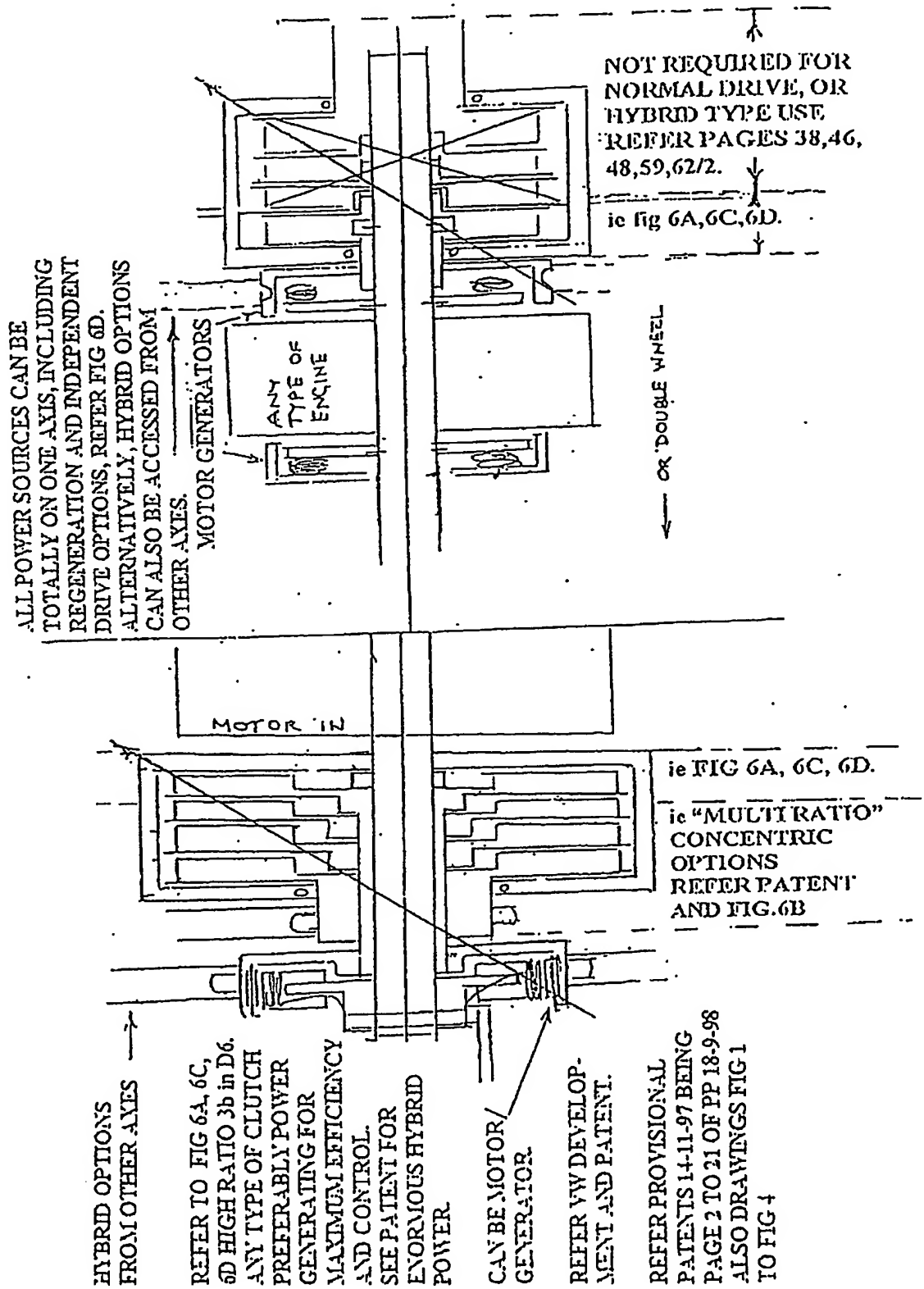


FIG. 29A

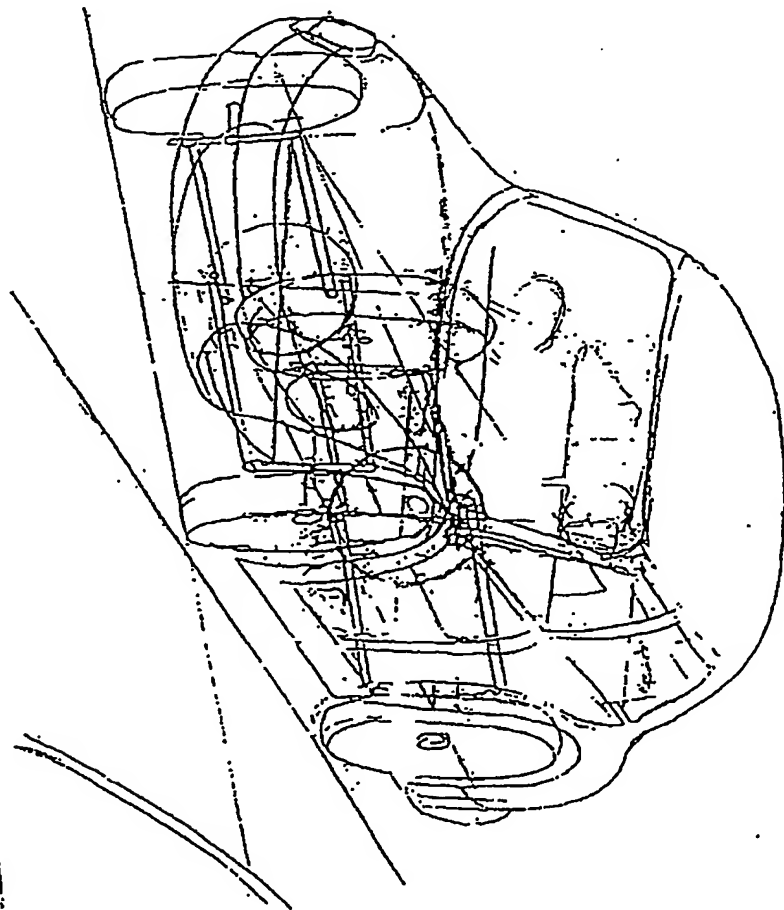
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FIG 29B



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Fig (30)



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